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MOTION PICTURE

AND TELEVISION

ENGINEERS

High-Speed Photography
Film Pickup
TV in Film Production
Electronic Motion Pictures
Small Motion Picture Studio
Light-Flux Meter
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Nonphotographic Aspects
Sound on Kodachrome
Tape Transport
TV Studio Lighting
American Standards

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Practical Application of High-Speed Photography in Business Machines

By WILLARD L. HICKS and ROBERT L. WRIGHT

Discussed is the use of a high-speed camera as a tool in the Company's Engineering Division. Motion of fast moving parts is easily plotted by the use of a special timing disc graduated to 0.001 sec. Through the use of negative film, film can be processed for study within two hours.

THE DESIGN AND PROVING of the light, fast-moving parts in business machine mechanisms has been a difficult and time-consuming job. Advances in this field, while continuous, have been obtained only at a high cost in time and labor.

In our study of the action of these mechanisms, we had been limited to the current instrumentation methods and to others which we improvised to record time and movement. But we had felt for some time that if we could slow down or actually stop the normal, rapid motion of parts under study, then our engineering work would be greatly simplified.

Five years ago our Engineering Group had a particularly perplexing problem which had been under study for several years and to which a number of solutions were submitted. The question was how could we choose the right one without extensive testing. A high-speed camera capable of exposing 3000 frames a second was procured and put to work on this problem. The camera quickly proved to the satisfaction of engineering the correct solution.

Presented on May 2, 1951, at the Society's Convention in New York, by Willard L. Hicks and Robert L. Wright, Standards Div., Burroughs Adding Machine Co., 6071 Second Ave., Detroit 32.

An entirely new tool had been added to our engineering analysis. However, it was a problem to sell this method to all of our development groups. Today, our high-speed camera is very much in demand and our camera work has developed to the point where we take pictures in the morning and have them ready for analysis the afternoon of the same day.

The high-speed camera like any other analyzing equipment can be used only to study or determine trouble if you know where to look for it. The mere shooting of pictures generally results in only exposing film of no value. If a machine is missing operations, you will have only approximately one second to film that operation and may have to shoot more than one roll of film to pick it up.

Adding machine operations are rather complex. Let us briefly outline one of our typical operations so that our application of high-speed photography can be more readily understood. In the hammer section of an accounting machine, spring-energized hammers are used for printing on rubber platens or printer rolls. In this operation we are concerned with the initial release of the hammer, its acceleration and final velocity, the rebound of the hammer and type from the printer roll, the deflection and vibration of the magazine spring

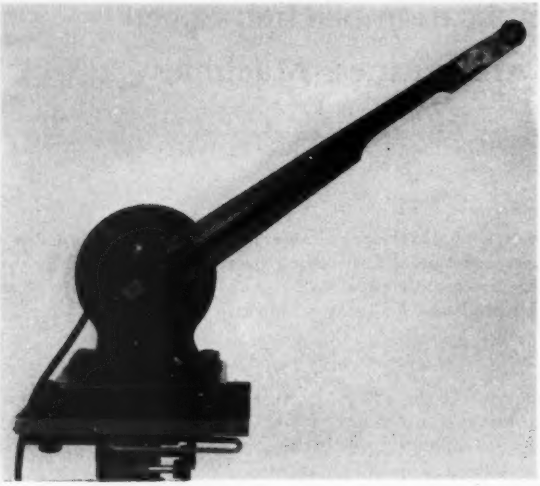

Figure 1

that returns the type, the time of reset for a repeat stroke of the hammer with relation to the complete machine cycle, the motion of the hammer on rebound, and the degree of certainty of the pickup or latching of the hammer in the cycle.

Now let us consider time in this operation. This particular machine is operating at 128 printing strokes per minute, or less than one-half second per stroke. However, the hammer itself fires and prints in 0.008 sec and is picked up into a latched position in a total of 0.130 sec.

In other mechanisms we have found that actual layout displacements are increased due to elastic bending while in motion. In some cases such overthrow movements cause machine lock-ups, wrong operations, and fatigue failures.

Time studies, such as those of time required for specific mechanical operation, accelerations, and velocity are made with a timer (Fig. 1) developed by Burroughs for our use. This timer consists essentially of a 1-in. disc graduated to 0.001 sec, revolving at 3000 rpm attached to an 18 in. long shaft which can be rotated in two planes. The timer is placed in the field of every picture taken with very little sacrifice of field. Very precise timing can be made while running the film through a time study projector, a frame at a time if necessary.

Accelerations, velocities and deflections determinations are made by enlarging the picture on a screen through a time study projector. The picture enlargement factor can be obtained by photographing a scale in the field of the parts to be studied. Displacement can then be measured directly. Acceleration and velocity are determined by plotting time against distance; however, it is necessary to center each frame, on the screen or paper, on known reference points.

Where we have machine cycles of less than one second, it is sometimes necessary to incorporate microswitches to start the camera. The microswitches are attached to, and are directly driven by, the mechanism to be photographed at a required instant in the machine cycle. It must be remembered that a further allowance of approximately 50 ft of film may be required to allow the camera to reach its maximum speed.

The camera equipment is extensively used for the following applications:

1. To prove plate models of new developments before breakdown testing and final design.

2. Improve operation of existing machines.

3. Study the effects of proper and improper adjustments.

4. Establish test fixture comparisons of machine movements for correlation in testing.

5. Determining the lag or overthrow of cam-driven parts.

6. Study the flow of metals in shop cold working operations.

7. Study the actions of springs in motion.

A typical lighting setup used at Burroughs involves concentrating the light beams of four RSP #2 Photospot Lamps on the subject, with the lamps approximately one foot from the subject. A lens opening of *f*/5.6 and maximum picture speed of 3000 frames/sec will result in good exposure on Kodak Super-XX Negative Film. If a greater depth of field is required, 750 R Lamps may be used so that ample exposure can be obtained at the same camera speed, while at the same time smaller lens openings can be used, thereby increasing the depth of field.

Figure 2 is an example of a lighting setup for the carriage tabulation picture which also shows our camera equipment and subject. In this exposure, two lamps (RSP #2) placed approximately one foot from the subject were used. The lens opening was *f*/8. A 50% rheostat setting equivalent to approximately 1500 frames/sec was used.

The camera equipment is a standard Eastman Kodak Co. Type 3, High-Speed Camera with a standard 63-mm, *f*/2.7 lens.

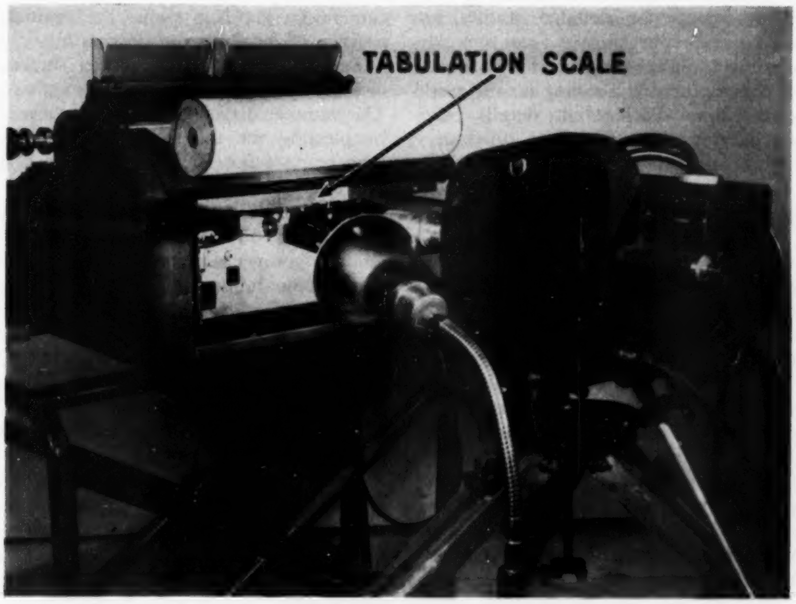

Figure 2

Figure 3

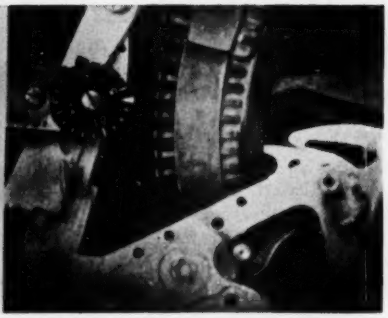

Figure 4

Recently, we obtained a new Kodak Cine Ektar 25-mm, $f/1.9$ lens which is designed to increase our present 63-mm field width by $2\frac{1}{2}$ times. This lens will greatly expand our present field coverage.

Eastman Super-XX Negative Film is used in taking these pictures, which has certain advantages for our use. Its ease and time involved in developing is a great asset (approximately one hour). Enlargements for detailed studies for record and report purposes can be made directly from the negative film. Then, of course, there is a saving on the price of the film. To highlight details, parts are painted with a flat-white, quick-drying, heat-resistant paint.

Type Hammer Printing

Figures 3, 4 and 5 represent three pictures taken at 2000 frames/sec of a critical printing action, the solution of which was greatly expedited through the use of high-speed photography. The cam slot indicated by the arrow shown in Fig. 3 represents the portion of this action which gave us our trouble. In Fig. 3, the spring-driven driver roll follows the upper cam surface and propels the hammer forward. This cam surface is a portion of the hammer shown by the arrow. As the roll follows this cam surface into the well, it is necessary that there be sufficient clearance between the relatively stationary roller at this instant after firing and the cam projection lip indicated by arrow (Fig. 3) which is called the cam velocity high-point. One thirty-second of an inch less clearance on occasion will cause the free hammer to rebound into the type and print a second time. Figure 5 arrow shows this condition if you will visualize this section with a further build-up of $\frac{1}{32}$ in. on the upper cam face. Figure 4 shows the normal position of the drive roll on printing.

The time displacement curves shown in Fig. 6 were plotted from this action. The hammer displacement was obtained by plotting the travel of the hammer type contact face on paper shown by small arrow in Fig. 5. It is necessary to realign the picture between frames by centering on *established picture reference points* to compensate for machine movement while in operation. The actual displacement can be obtained by dividing the projected screen displacement by the enlargement factor. The enlargement factor can be obtained by dividing the enlarged part dimension by the actual part size. The time is read directly from the timer.

The curves A "original design" and B "corrected design" (Fig. 6) were plotted frame by frame. These curves indicate we lost little in velocity through the reduction of the cam face (Fig. 3) at curve point C. Point D graphically indicates adequate drive-roll clearance

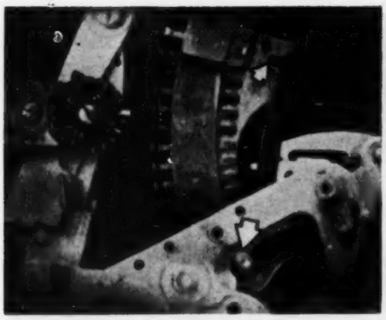

Figure 5

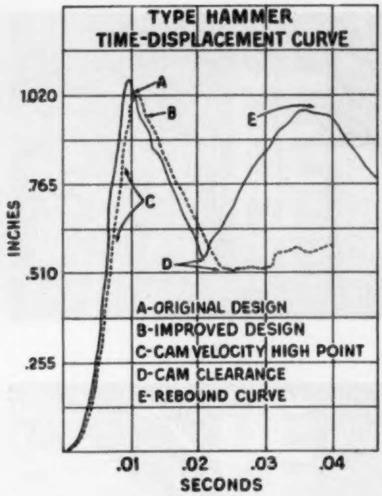

Figure 6

between the cam face and the roll. Notice the sharp hammer rebound shown by E of curve A. Very little hammer rebound is occurring between the hammer and the drive roll as shown in curve B. In the picture represented by curve B, the height of the rebound is approximately 0.045 in. under the first displacement. While this is under the amount of rebound necessary to cause a double print, the tendency to double print coupled with machine vibration frequency would further magnify this rebound. Consequently, through the correction of the cam slot and further testing, we were able to eliminate completely this difficult problem.

Simpler time-displacement plotting can be obtained by mounting simple reference points on the machine or mounting a direct reading scale as shown under the carriage tabulation example. Occasionally, abnormal actions are unexpectedly revealed during film study. In such cases, even though reading scales were not induced, the information for plotting can still be obtained by improvisation. Many curves have been plotted of this action, involving changes in hammer balance, hammer weight and spring force.

Another similar type-hammer printing section is shown in Figs. 7, 8 and 9. In this example the type magazine is exposed to show a 0.020 in. diameter music wire hair spring. This spring is used to restore the type to a normal position after printing. The hammer and type are highlighted with white paint; the spring blackened with carbon. The camera speed was 3000 frames/sec.

The three pictures shown are not consecutive frames, but are three of six frames embracing a cycle of 0.002 sec.

In Fig. 7 the second hammer has driven its type, while the first hammer is about to contact its type. Figure 8 shows that the first hammer has now driven its type ahead of the hammer. Note that the type shoe is driving the hair spring. Figure 9 also shows that the hammer has caught up with the type. Note that the hair spring is now out of contact with the type shoe.

The timer reading of 0.006 (Fig. 7), from 0.008 as shown in Fig. 9, represents a difference of 0.002 sec which is the time required for this printing action. These pictures were primarily used to study the whip action of type hair springs, which was so fast that our camera speed of 3000 frames/sec was not quite fast enough.

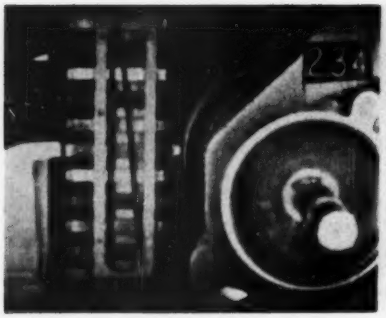

Figure 7

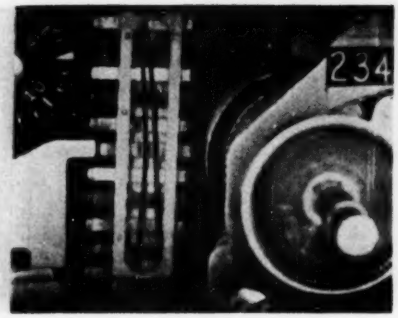

Figure 8

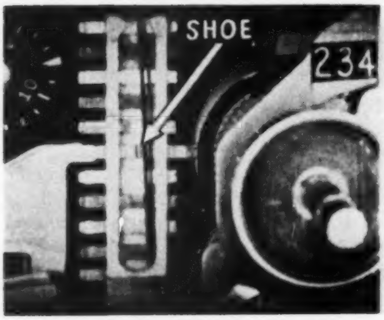

Figure 9

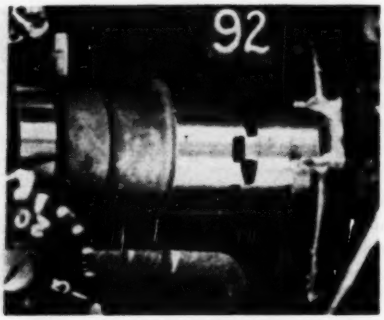

Figure 10

Multiple-Tooth Engagement Drive Clutch

In this particular application, the clutch is required to engage once for each complete machine operation. This clutch is turning at approximately 130 rpm. We had experienced some trouble with a loss of machine operations, caused by the clutch not being completely engaged at the beginning of the machine stroke. At 180 degrees of rotation of the clutch, the machine load reverses while the clutch is still rotating in the same direction. This machine reversal point removes the tooth engaging pressure, which occasionally disengaged the clutches.

A high-speed picture taken at 1500 frames/sec through an exposed housing assembly indicated that this trouble was resulting from a point-to-point tooth engagement as shown in Fig. 10.

Figure 11 indicates a desired tooth engagement position under the original design. It will be noticed that the left side tooth faces are cut at an angle to induce positive engagement; but still, occasionally improper point-to-point tooth engagement resulted (Fig. 10).

Figure 12 shows a helper pawl in position. This pawl prevents point-to-point tooth engagement by bearing against the entire face of the meshing sector. On rotation of this meshing sector, the pawl is displaced to allow complete engagement of the clutch tooth. In this instance high-speed photography helped us to eliminate this problem and to devise a positive method for insuring proper engagement.

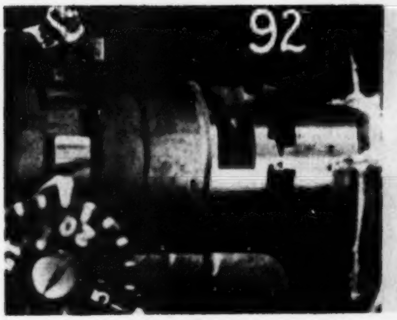

Figure 11

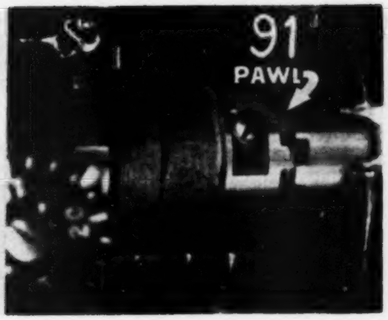

Figure 12

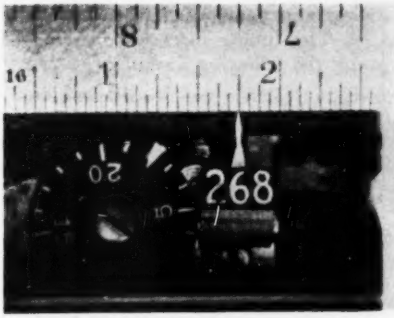

Figure 13

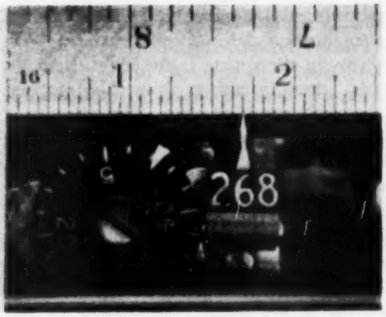

Figure 14

Carriage Tabulation (see Fig. 2)

Briefly this mechanism establishes a desired stopping position for indexing columns of figures on printed paper. In this machine-driven operation, we are concerned with various carriage weights, carriage velocity, friction clutches and friction breaks to reduce the carriage speed, all of which are timed together in the machine cycle and brought to a stop position through the action of a spring operated bumper mechanism.

Figures 13 and 14 represent our method of plotting a displacement-time curve as shown in Fig. 15. Pictures were taken at 1800 frames/sec. A steel scale is attached to the carriage with a fixed reference point. An examination of these Figs. 13 and 14 indicates a time

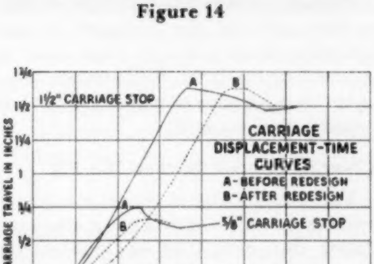

Figure 15

change of from 0.0023 sec to 0.0073 sec for $\frac{1}{16}$ in. of displacement. This represents .005 of a second for the time required to travel $\frac{1}{16}$ of an inch. In this manner the curves shown in Fig. 15 were plotted. These curves were plotted

for $\frac{5}{8}$ in. and $1\frac{1}{2}$ in. carriage tabulation stops.

The carriage displacement-time curves represent two conditions, Curve A "before redesign" and Curve B "after redesign." The changes basically affected the clutch and brake. The carriage weight and tabulation stops were picked to represent the most critical conditions which were determined from previous picture variations. The carriage is traveling to the left, at the $1\frac{1}{2}$-in. carriage stop position, the curve represented by curve A clearly shows that more energy is required to stop the old design than the new design established by curve B. The curve A also shows a definite rebound and overthrow in the spring bumper on the right side, demonstrating that this bumper absorbed more energy. The overthrow in the left side spring bumper is very nearly equal. In the case of the $\frac{5}{8}$-in. carriage tabulation stop, a greater amount of bumper energy absorption is required in the old design versus the new design. The overthrow in the left side bumper is greater and overthrow also occurs in the right side bumper. It is interesting to note that the curves shift to the right in the changed design, indicating that a longer total time is required to reach the first bumper stop. Other changes have been made to further improve this example.

Timer Calibration Method (see Fig. 1)

The timer consists of an a-c motor running at 3570 rpm and a one-inch timing disc with 0.001-sec graduations up to 0.020 sec per revolution of the disc. A reduction gear train was used through a long arm to drive the timing disc at 3000 rpm.

In order to determine the accuracy of the above-mentioned equipment, the following procedure was followed:

1. A Strobotac (General Radio Co.) was calibrated for 3000 rpm against a 2-pole synchronous motor at a line frequency of 60 $\pm$ 0.02 cycles.

2. The speed of the timing disc was then checked against the calibrated Strobotac at a line frequency of 60 $\pm$ 0.02 cycles and the speed was found to be 2992 rpm. This represents an error of 0.267% below 3000 rpm.

3. Because our line frequency has been known to vary from 59.5 to 60.5 cycles, these frequencies were then used to obtain the maximum and minimum timing disc speeds, again using the calibrated Strobotac for our speed determination. The values obtained were 2982 rpm at 59.5 cycles and 3007 rpm at 60.5 cycles. These speeds represent an error of 0.6% and 0.233% below and above 3000 rpm.

4. The timing discs were calibrated using the following formula:

$$\frac{60\ \text{sec/min}}{3000\ \text{rpm}} \times 1/20\ \text{rev./grad.} = 0.001\ \text{sec.}$$

The time interval between graduations at 2982 rpm is

$$\frac{60}{2982} \times 1/20 = 0.001006\ \text{sec}$$

and at 3007 rpm is

$$\frac{60}{3007} \times 1/20 = 0.0009977\ \text{sec.}$$

Therefore our accuracy is 0.001 sec $\begin{matrix} +\ .6\% \\ -\ .23\% \end{matrix}$

Direct line circuit overloads do not affect the timer motor. This was checked by a Strobotac.

This camera is not nearly as complicated as one would think, and a basic operating knowledge of the camera can be readily acquired by anyone qualified for design and production research work.

It is surprising, even in pictures, how much additional information can be gained by subsequent viewing of the same picture.

In conclusion, we have found that this application of high-speed photography enables us through actual pictures to analyze quickly mechanical problems and arrive at proper solutions.

Practical Use of Iconoscopes and Image Orthicons as Film Pickup Devices

By K. B. BENSON and A. ETTLINGER

At the present time, both iconoscopes and image orthicons are employed in monochrome television broadcasting for transmission of motion picture film. The theoretical considerations of such operation have been covered quite thoroughly in the literature, while the many practical problems have received very little attention. A discussion of the correlation between the basic theoretical problems of television motion picture film pickup and their practical solutions as presently employed in television broadcasting is given.

From a picture and sound reproduction standpoint, television film transmission should equal in quality live programming, just as in aural broadcasting recorded playbacks can be indistinguishable from direct pickups. Actually the development of the image orthicon camera for direct pickup has progressed so fast that the majority of the programs recorded on film do not equal in quality the best live pickups. This situation is further aggravated, particularly in the case of the new television stations, by the fact that more emphasis is often placed upon studio or live pickups, even though a major portion of a station's more important program material may be reproduced from film.

As for the problem of raising the standards of television film reproduction, there are two roads to follow: one, the improvement of presently used equipment and operating techniques; and two, the introduction of new types of equipment and methods of film transmission and pickup. We shall first discuss a few of the problems associated with the operation of the iconoscope, the tube currently used for film pickup at the majority of this country's television stations, and then we shall describe the problems encountered with one of the more obvious approaches to new methods of film pickup, the use of the image orthicon.

The iconoscope operating problems may be broken down into three categories: (1) the proper operating conditions of the pickup tube; (2) the treatment of the associated video circuits; and (3) the operating techniques for maximum picture quality.

Figure 1 shows the transfer characteristic of the 1850A iconoscope for both continuous illumination and for pulsed illumination such as is used for motion picture film pickup. The figures of illumination for this latter curve have been corrected by a 5% duty-cycle factor

Presented on May 1, 1951, at the Society's Convention in New York, by K. B. Benson and A. Ettlinger, Columbia Broadcasting System, Inc., 485 Madison Ave., New York 22, N. Y.

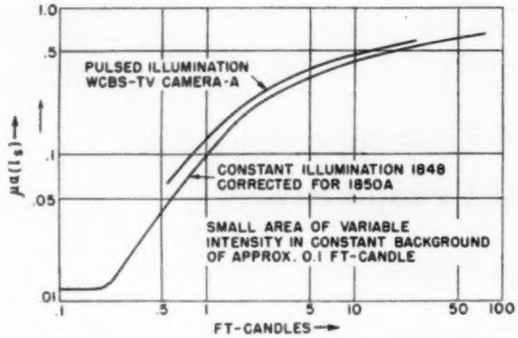

Fig. 1. Transfer characteristic of the 1850A iconoscope for both continuous illumination and for pulsed illumination.

to average values so as to correspond to values for the steady-state curve. It is readily apparent that above a value of 20 to 30 ft-c, the already low value of gamma is further reduced. This may be interpreted to mean that the tube will produce only a minor variation of signal output for a rather wide range of film densities. Hence, such operation will invariably result in serious white compression. Therefore, if an iconoscope is in good condition and used with films of normal densities, it should be unnecessary to employ any excessive illumination from the projector. In fact, in practice a light level such as is produced by a gap lamp machine or a 750- to 1000-w incandescent machine with a reasonably fast lens has been found ample. Any higher value will usually cause some additional white compression at the expense of a negligible signal increase. Thus, if it is found that abnormally high light levels are required to obtain a satisfactory signal-to-noise ratio, either the iconoscope is producing too low a signal output to be of any further use or the preamplifier is inadequate with regard to noise factor or overall gain.

Attempts have been made to correct, by electrical circuits of nonlinear amplitude characteristics, the white compression or low gamma of the iconoscope tube. However, two serious difficulties are encountered. For one, the increased gain for highlight signals produces not only an increase in the highlight signal but an increase in the noise level. This increase in noise level in the highlight area has been found to be quite objectionable in the reproduced television picture. Secondly, the accentuated variation in white levels resulting from expansion of the highlight signals considerably complicates the task of the video control technician, and his inability to cope with such changes frequently results in unsatisfactory television reproduction of the film picture.

The correction which is desired of the transfer characteristic of the overall film exposure, development and playback process can be obtained by the use of the negative film for the iconoscope pickup, rather than a positive print. In this process, to produce a positive image upon the viewing tube, the video signal may be reversed in polarity in the film camera video amplifier circuits. Both calculations and measurements show that the resultant transfer characteristic not only provides amplitude expansion of the picture highlight signals, which corrects for the compression of the iconoscope and recording process, but, in addition, provides a little useful shadow expansion. Further, since spurious signal effects such as edge flare appear black rather than white, they are not apparent to the viewer.

The practicability of such a method of transfer characteristic correction has

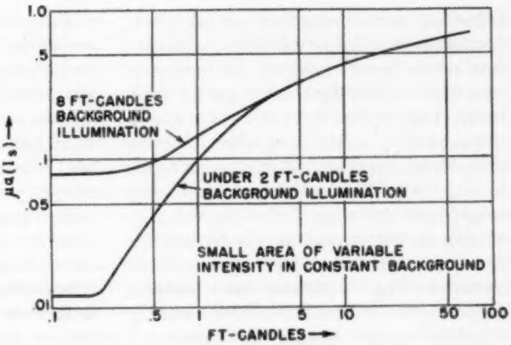

Fig. 2. Iconoscope transfer characteristic for two different levels of background illumination.

been verified by the success of its extensive use at CBS for the release in New York of television recordings of feature Hollywood programs. Using 35-mm negatives with an iconoscope for pickup, CBS has obtained picture quality which compares quite favorably with that of live studio transmissions.

Figure 2 again shows an iconoscope transfer characteristic, but in this case for two different levels of illumination. It can be seen that the signal output drops with increased average light level, assuming the maximum and minimum film densities have remained the same. Thus, in order to maintain as high a signal level as possible, and an accompanying high signal-to-noise ratio, the spurious light level upon the mosaic should be maintained at a minimum and as large a mosaic area scanned as is possible. Consequently, the edge light should be a narrow band sharply focused upon the extreme edges of the mosaic; the back light and iconoscope should be masked whenever necessary to direct the light to the glass envelope and not upon the mosaic; and from the film-production angle, exceptionally high key techniques should be avoided. Since chromatic aberrations exist in the iconoscope glass, color filters limiting the back- and edge-light emission to a spectrum corresponding to the peak sensitivity of the pickup tube will further reduce the spurious light reaching the mosaic. In addition, similar optical filters applied to the projector light beam will improve the fine detail contrast of the reproduced picture. In fact, in many cases such techniques will produce as much as 50 lines improvement in detail.

Figure 3 shows the spectral response of the iconoscope and of a filter suitable for the above use. It is apparent that while the 1850A's response peaks at about 460 mμ, there is still a fair degree of sensitivity in the red and infrared regions. Such radiation from the film projector can be removed quite thoroughly by a simple glass filter.

Aside from the iconoscope itself, of prime importance in obtaining the best possible reproduction of film is the noise factor of the low-level amplifier stages

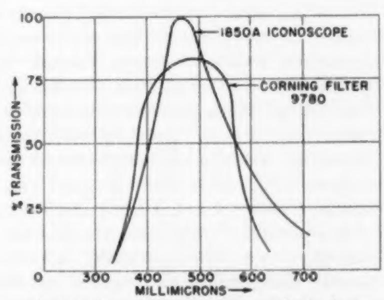

Fig. 3. Spectral response of the iconoscope and transmission of a filter suitable for improvement of detail contrast of reproduced pictures.

following the iconoscope signal plate. Unfortunately, in practice the major portion of the noise, both of the fine-grain shot type and of the low-frequency type, from vibration and hum occurs in the vacuum-tube video amplifiers, specifically those operating at the lowest signal levels. Such low levels occur at the first stage, and the stage following the conventional high-frequency compensation network. The transfer characteristics shown in Fig. 1 indicate that a signal output in the order of 10 to 40 mv may be obtained under normal operation. A similar level will exist after compensation. A triode preamplifier, such as a 6J6, 6J4, 6AK5 or 5654, operating at high transconductance and low plate current will give good results. The iconoscope signal-plate output lead should be small bare wire in order to reduce stray capacities to a minimum. Shock mounting should be applied to the amplifier tube to reduce microphonics. As to the compensated stage, here again shock mounting should be employed. Since input capacities are not too important in this stage, the 6BC6 with its high transconductance and good stability has been found to give excellent results. One other likely candidate, the 6AH6, has proven to be unsuitable because of excessive heater-to-cathode leakage. Shielded filament leads for all low-level stages will greatly assist in the elimination of any stray low-frequency interference. All tubes, except the two abovementioned low-level stages, should be operated so as to be capable of considerable voltage swing without compression. Frequently, certain operating conditions may cause spurious signals to exceed the picture information and, if good conservative design has not been employed, such operating conditions cause overloading of the video amplifier and resultant compression of portions of the video signal. Needless to say, with such low levels of signal all shielding and grounding should be very thorough and complete.

From the operational standpoint, there are three adjustments which may mean the difference between excellent film reproduction or just mediocre results. These are: (1) iconoscope beam, (2) edge light, and (3) back light. All three are interlocking in adjustment and if properly set up will be satisfactory for a wide range of films and will greatly reduce the necessity of continual readjustment of other controls during a pickup. The beam should be set to a point where a further increase will produce only a minor improvement in signal-to-noise ratio. The absolute value of this setting will depend directly upon the excellence of the video amplifier. An excessive beam will cause an objectionable graininess in the picture plus serious variations in shading and edge flare. Once the beam is set it will be satisfactory for almost all operation. Above all, it should not be used as a gain control; all video level adjustments should be made with the video gain control. With a proper beam adjustment, the edge light may be set to a level which eliminates all flare with a dark scene projected upon the mosaic. Best results over a wide range in film quality will occur when the maximum possible area of the mosaic is scanned and a narrow, intense band of edge light is employed. To complement this adjustment, a setting of the back light will be found which will cause a reduction of the application pulse. Any additional back light will cause excessive application pulse and poor field storage upon the mosaic.

Investigation of the Image Orthicon

Up to the present time, the use of the image orthicon, rather than the iconoscope, for film transmission has been investigated by relatively few television broadcasters. The reasons for this limited use have been twofold: first, taking into consideration the initial cost and the average useful life of the two tubes, the hourly cost of image orthicons is found to run about three times that of

iconoscopes; and second, to realize maximum picture quality, rather extensive mechanical modifications are necessary on presently available television projection equipment to adapt it to image orthicon use. However, the increased life of the newer image orthicons has reduced the operating expense somewhat and this factor, plus difficulties of procuring good iconoscopes, has made the use of the image orthicon for film pickup considerably more inviting.

The major installation problems encountered with an image-orthicon camera chain are those concerned with the modification of the television projector, since most of these units are designed for the relatively high intensity and large-image operation required by the iconoscope. The basic requirements for image-orthicon application are: (1) an image of readily adjustable size from approximately 1.2 to 1.6 in. in width; (2) a throw of about 14 in.; and (3) an illumination level of from 1000 to 5000 times lower than that normally used for the iconoscope. Methods of satisfying these requirements are discussed in greater detail below.

The reduced image size may be obtained by extending the mount of the usual 3- or 4-in. projection lens about 2 in. and focusing the image directly upon the image-orthicon photocathode. Such an extension of the lens mount must be of exceedingly rugged construction; otherwise any vibration of the projector will result in a loss in accuracy of registration of the small image upon the tube. In fact, experience has indicated that the problem of instability of any longer extensions prohibits the use of a lens of greater focal length than 4 in. This limitation of throw rules out the use of the usual method of diplexing two projectors through mirrors into one camera. If more than one projector is to be used with one camera, a turret camera mount has proven to be a very practical solution.

The optical focusing arrangement in the standard image-orthicon camera provides a useful method for adjustment of picture size upon the photocathode. The arrangement should be such that the corners of the projected image slightly overlap the periphery of the photocathode when the image-orthicon tube is at the end of the focusing range. As the tube is moved forward and the lens refocused, the projected image will become progressively smaller until the entire image is within the photocathode area. Thus, the image size can be easily readjusted to match any reduction of scanning raster size necessary as the image orthicon ages. The change in the position of the projection lens often causes an uneven light distribution over the resultant image which may be corrected by removal of one of the condenser lens elements. Since this modification increases the focal length of the condenser system, it may be necessary to insert a diffusing glass in place of the eliminated lens in order to remove an image of the projection lamp filament.

Several approaches to the problem of reduction of light intensity are possible. Some light will be lost in the basic modification of the condenser lens. In addition, since the projection lens will not be used at its designed magnification, some loss in corner resolution will occur. This loss may be corrected, and at the same time a light reduction obtained, by stopping the lens down about $f/8$ or $f/11$ (an opening of about $\frac{3}{8}$ in.). These two expedients provide a reduction factor in illumination of 100 or so. In the case of the incandescent projector, a further reduction in the order of 10 to 20 can be very easily provided by the substitution of a 50-w or smaller projection lamp. If the efficiency of the condenser lens system has not been greatly impaired, a 6-v, 3-amp, prefocused unit is an even more convenient means of reducing the light intensity.

Because of the limited contrast acceptance of the image orthicon, compared to the contrast range available from motion

picture film, it is essential that a means be provided for readily available operational control of the projector light level. If a small incandescent lamp is employed, a simple control consists of a series rheostat in the lamp circuit. Gap-lamp, pulsed light projectors, however, present a more difficult problem in light control as well as in light reduction. One successful answer consists of a combination of a neutral density filter to provide a fixed value of light reduction, and two Polaroid filters for a variable element. The degree of reduction obtained from the Polaroids may be varied by rotation of one filter in its own plane through selsyn control from the operating position.

Concerning the image-orthicon camera, the only absolutely essential modification is the provision for reversal of the direction of vertical scan and, if an optical diplexing system is contemplated, reversal of the horizontal scan. An additional and very desirable modification is the removal of the scanning controls (size and centering) to the camera-control position, so as to provide the operator with a means of conveniently compensating for differences in film framing and camera scanning drift. In the event that transmission of negative film may be required, a switch and circuit for reversal of video-signal polarity is also required. The quality of the transmission of negative film through an image orthicon film chain is usually poor, however, and consequently such operation should be used only in an emergency.

From an operation standpoint, it may first appear that the image orthicon would require fewer operating adjustments than the iconoscope because of its freedom from shading difficulties; however, since electron redistribution effects cause the transfer characteristic of the image to vary over a wide range as average light level and distribution of scene brightness change, it, too, requires a frequent readjustment of controls. Although this factor is not very troublesome with carefully processed film having a narrow density range, with the average film it may be almost impossible to avoid drastic shifts in signal level or sudden complete saturation at either end of the transfer characteristic. If such changes can be controlled, it will be found that the image orthicon will produce an apparent higher definition than the iconoscope. This is because this electron redistribution, in effect, creates an expanded transfer characteristic in areas of fine detail.

The constant low gamma of the iconoscope results in a signal level reasonably independent of variations in average film densities, while the image orthicon is quite critical as to such variations. Thus, the image orthicon does not have as universal an application to film pickup as does the iconoscope, but for films having a low density range (in the order of 1.0 to 1.5) the image orthicon is capable of producing a picture of considerably improved definition and gray scale over that from an iconoscope, and at an operating cost not greatly in excess of the latter.

Experimental Utilization of TV Equipment in Navy Training Film Production

By J. S. LEFFEN

An acceptable training film can be rapidly produced by utilizing television cameras and a video recorder to combine shooting and editing. High equipment costs and relative immobility of equipment limit application to large-scale producers except in cases where speed of production is of paramount importance.

The Navy has long felt the need for a rapid method of producing training films for immediate utilization in times of emergency. Conventional techniques have produced a high-quality product in a reasonable time and have been entirely adequate for peacetime operation. In times of emergency, past experience has shown that new equipment is frequently produced and in use in the fleet before the training film on its operation arrives on the scene.

In an effort to speed up production, several experiments, including simultaneous multicamera coverage, have been attempted with varying degrees of success. The Naval Photographic Center's successful experimentation with kinescope recording aroused an interest in the possibility of utilizing television equipment in motion picture production.

It was believed that an acceptable continuous "edited" negative of a ten-minute training film sequence, complete with titles and effects, could be produced by use of two or three camera chains, a camera switching and effects unit and a kinescope recording unit. By the addition of standard double system sound, title music, narration, dialogue and sound effects could be added. The actual production would then consist of rehearsal, shooting and processing, completely eliminating the editorial phase. While it was realized that use of present television scanning standards would inevitably lead to some sacrifice of pictorial quality, it was believed that in view of the probable saving of time, this loss would be acceptable for some types of subject matter.

Presented on April 30, 1951, at the Society's Convention at New York, by Lt. Comdr. J. S. Leffen, USN, U.S. Naval Photographic Center, Naval Air Station, Anacostia, D.C. The opinions and assertions contained herein are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the naval service at large.

A survey of available commercial equipment disclosed that the products of several manufacturers would probably fulfill our requirements. One manufacturer (General Precision Laboratory of Pleasantville, N.Y.) offered to make a two-camera chain, a camera switching unit and a kinescope recording unit available for experimentation. Noteworthy features of this equipment are: small size of the camera units, use of picture tube blanking rather than a mechanical shutter in the video recorder and addition of a "gamma correction amplifier" in the video chain of the recorder unit.

Since a project was on the books which seemed a natural for the proposed type of production technique, the offer was accepted and script writing commenced. In view of the probable difficulties to be encountered with wholly unfamiliar equipment, it was decided to keep the script as simple as possible. Subsequent events proved this a wise decision.

The equipment, upon arrival, was found to have been severely handled in shipment. Several days were spent in making temporary repairs and adjustments. This rough handling may have also been partially responsible for the continuous minor difficulties and failures which plagued the remainder of the experiment.

The manufacturer's experience in video recording had been primarily in production of a positive by photographing a negative image on the kinescope. It was originally planned to make extensive sensitometric tests with varying camera settings, video gamma, exposure and gamma of development to get the best possible negative. The initial loss of time due to equipment damage made it necessary to seriously curtail these tests and they were abandoned completely as soon as a usable negative was produced. The emulsion stock used was Eastman Kodak Company #7373, a sound recording stock. This was in line with the film and equipment manufacturers' recommendations for kine recording for subsequent retelecast. It is possible that another emulsion might have been more suitable for the ultimate production of projection prints.

The video equipment was set up with the cameras on the sound stage, the camera control, switching and monitors in the stage projector booth which overlooks the stage and the video recorder in a room remote from the stage. The camera control operators and director, who operated the camera switching unit, were stationed in the stage projector booth. Two-way headset communications were available between the director and the assistant director and cameramen of the stage.

The sound mixer was stationed in a monitor room on the second deck overlooking the stage. From this position, he controlled the re-recorder used for title music and rode gain on the narration. An "on the air" picture monitor was provided at this station. In this temporary installation, it was necessary to leave the stage and projector booth doors open to provide passageway for cables. This resulted in a substantial increase in ambient noise level. To combat this, the narrator was provided with a microphone on a chest plate. This resulted in an improved signal-to-noise ratio and greater freedom of action. It was hoped that the remainder of the ambient noise would simulate that of the scene depicted.

Completion of repairs, sensitometric tests and setup required so much time that it was necessary to commence rehearsals simultaneously with indoctrination in equipment operation.

So little time remained to use the equipment, that it was decided to dismiss technical defects such as poor sweep linearity, improper view-finder alignment and less than optimum lighting and print quality as factors

which could be corrected if time were available, and to proceed with rehearsals and shooting.

With the commencement of rehearsals, additional difficulties were encountered. It was discovered that the detents on the camera-lens turrets were not strong enough to position positively the ten-inch lenses. Since these lenses could not be used, more camera movements were required than had been originally scheduled.

In all, a total of fourteen hours of rehearsal and shooting were required. While this may seem inordinately long, it should be remembered that neither the director nor the cameraman had ever used television equipment before. The director was performing the dual job of director and technical director. With the exception of the narrator, no professional acting talent was employed.

The original objective of producing a continuous negative in one take was not quite achieved. As time ran out, one almost perfect take was made and only enough time remained to make two short pickup shots.

Although this experiment was too limited in scope to justify definite conclusions, the following general comparisons with standard motion picture equipment and techniques appear to be justified:

1. The equipment is not fully portable. This remark applies particularly to the video recorder unit.

2. The equipment is not completely reliable. While engineered and manufactured to high standards, failures are much more common than in the more familiar motion picture sound equipment. Constant maintenance is required.

3. A larger production crew is required. The minimum increase consists of one camera control unit operator for camera, a technical director and an operator for the video recorder.

4. Substantial saving in time and complete elimination of editorial and rerecording cost is possible.

5. Pictorial quality, while not up to motion picture standards, is acceptable for most types of subject matter encountered in training film production. The picture looks better than a purely mathematical analysis of resolution would indicate.

6. Sound quality, due to the elimination of several re-recording generations, is better than average for 16-mm prints.

In conclusion, the high initial cost of television equipment requires a large volume of production before reduction of editorial costs make this type of operation economically feasible. The large amount of time saved might make this technique desirable for some producers in spite of the economic penalty.

From the Navy's point of view, the production workload does not appear to warrant purchase of such equipment at this time. In time of full mobilization, when the workload greatly increases and production time must be greatly shortened, it is probable that serious consideration will be given to employing this technique.

Acknowledgment is hereby made to the personnel of General Precision Laboratory, whose enthusiastic cooperation made this experiment possible. The film made in the course of the experiment is now in use and is adequately fulfilling its purpose.

Techniques for the Production of Electronic Motion Pictures

By E. A. HUNGERFORD, JR.

This paper examines the techniques now current and estimates the possibilities of accomplishing the production of truly electronic motion pictures of sufficient technical quality to reproject into the television broadcast channels.

Several high-speed techniques for motion picture production have made their appearance in the last few years. The goal of these techniques is to produce motion pictures at a cost the television industry can afford to pay. All of these techniques are logical progressions toward the ultimate method of producing movies using high-resolution television cameras which feed to high-quality video recorders for picture and the usual film recorders for sound.

Television broadcasting has grown much more rapidly than was ever anticipated. With this growth has come a demand for visual programming which severely taxes the facilities and talent of the entertainment world.

In the beginning, television borrowed from all existing allied fields. From the theater came talent who could give a sustained performance since television is a real time medium. From radio came the know-how in electronics and the production techniques for handling special events and sports. From radio, too, came money by the millions of dollars. Even though radio knew that nurturing television would put its balance sheet in jeopardy for the years until television became profitable, radio plowed ahead with full confidence that the day of profits would eventually come. It is now nearly here. One great television network has recently reported black-ink operations; many individual stations have achieved this goal.

Television borrowed from motion pictures, too. A visit to the early television studios was a visit to Hollywood in miniature. The lights were identical; the camera dollies were the same; so were the microphone booms. Every applicable production trick was borrowed to get television under way.

Production Time Reduced

Soon some changes began to occur. Fixed lighting was replaced by systems which could be controlled during performances. New types of dollies ap-

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Presented on May 3, 1951, at the Society's Convention at New York, by E. A. Hungerford, Jr., General Precision Laboratory, Inc., Pleasantville, N.Y.

peared. New techniques developed. Always the goal was the same—to speed up production of visual material. In the last ten years much progress has been made in fast techniques for television production. For example, complete one-hour dramatic programs are produced in three to five weeks. Actual camera rehearsal time is often only eight to twelve hours. Yet the final production is much like a feature motion picture. Since most such programs are produced live, the actors give sustained performances, which further heightens the effect.

Television has now grown up and is ready to pay its debt to motion pictures.

Some of these same high-speed techniques are adaptable to the moving picture industry and will bring the costs of production down to a point where television can pay for the costs involved.

At this point it is appropriate to ask the question, "Does Hollywood really want to produce films for television?" The answer must come back in the affirmative for several reasons. First of all, the quantity of film required by television so far exceeds the imagination that from a quantity viewpoint alone the market is attractive. And if production can be artistic, too, it will represent a real challenge to the ingenuity of Hollywood. But there is another very big reason. This has its roots in the theater, the outlet for Hollywood products. The theater today is undergoing a major adjustment. It is faced with direct competition for the first time: a small but lively lighted bottle in millions of television homes—essentially moving pictures, even though on pocket-sized screens. Many theaters realize that the best way to fight fire is with fire and the move to theater television is on. What will this mean?

Already one or two theaters are piping a television newsreel to their big screens. Television can and does do news better than the newsreels can hope to do. Soon there will be special events for theater television.* Some circuits even plan their own studios to generate variety shows for their big screen theater television. This will inevitably take away playing time from feature pictures. It now seems probable that the second feature may ultimately be replaced by theater television productions. To Hollywood this must mean less feature picture production for the theater, more overhead to spread over fewer pictures. This is hardly the way for an industry to advance in these competitive times. So Hollywood will have to look to a new market to make more efficient use of its splendid facilities for picture production. In seeking this new market no matter where it turns, Hollywood will encounter television and its voracious appetite for visual material.

To serve this market Hollywood will have to devise lower cost production methods because the day is still distant when television can spend $1,000,000 and up to run a feature picture. So, now motion pictures can borrow back from television some of the tricks which television has of necessity had to develop to cut its own production costs. Already the gap is being closed between high- and low-cost production. Let us examine the progress to date and see where it leads.

The Search for Economy

About a year ago an experiment was begun in Hollywood in connection with the Groucho Marx television show. The performance was strictly a radio show played in a typical radio studio. On the stage was a plain backdrop in front of which Mr. Marx seated himself on a stool. Here he met and interviewed his guests. From the center stage angle and shooting from the audience was a 35-mm

*Since the writing of this paper, several showings of sporting events have been made over exclusive theater television networks. The success of these demonstrations has proved beyond doubt the practicability and appeal of this medium.

motion picture camera. From stage left and from stage right were two other 35-mm cameras—all three grinding away continuously. At each location was another camera loaded with film and ready to take over when the active cameras ran low on film. In this way continuity could be maintained indefinitely. The cameras at stage left and stage right concentrated on close-ups while the camera at center stage angle provided the cover shot. By skillful editing, a motion picture was produced which had high impact and which constituted a very fine television show of high technical quality.

Here was a motion picture made in real time and, though a lot of film was probably destined for the cutting room floor, this waste was not large in terms of the value of the show as a whole. Yet the search for greater economy continued.

Next a system was devised where the director of the production would turn on a selection of motion picture cameras on cue to photograph a rehearsed script so that only the desired shot was being recorded on film. This saved film and also simplified editing and reduced the time from shooting to a finished print.

Evolution of Electronic Techniques

This latter system is much closer to the television technique in that some editing is attempted in the shooting of the scene. Then came the Vidicam system.

This next step was inevitable—the transition to the use of electronic viewfinders on film cameras. This system, now in actual use by the Vidicam Pictures Corp. of New York, operates as follows: To permit the producer to see what he is shooting a small television camera is mounted alongside the motion picture camera. The television camera is mechanically adjusted to see the same scene as that being viewed by the motion picture camera. The production is handled just as a television program would be handled. The director selects his shots on television monitors and instructs his cameramen in proper movement. When he selects his television shot he simultaneously starts the associated motion picture camera. Suitable bloops are applied to the sound track to assist in editing. This is really television production monitored by celluloid recording. Editing is practically accomplished as the production unfolds. Little or no film is wasted. Here is efficient production. The sustained performance is encouraged to the greatest extent possible. It is now practicable, with such a system, to turn out two 15-minute dramatic bits completely in a day's time including all rehearsals.

It is but a short step from Vidicam to the fully electronic technique. The motion picture camera is merely moved back into the laboratory next to the sound recorder and the picture is recorded in like manner by photographing a high-quality television image of suitable brilliance. Here is the way to capture all the time saving elements of television production for only television equipment is used. Picture recording is handled exactly as sound recording has been handled for twenty years. Television is paying back its debt to motion pictures. In return for the techniques borrowed in its earliest beginnings, television returns a smooth high-speed production technique well suited to turning out films for television use on a mass basis.

The Need for Higher Quality

The above technique viewed another way is really a kinescope recording and as such does not enjoy an enviable reputation for quality as yet. But the results are improving fast and over the past two years new equipment has come on the market which equals the best that can be done with 16-mm film even when photographed directly. And these results can be still much better. Present-day television camera equipment is designed to feed television transmitters for home television. The limitations in the trans-

mitters and in the home receivers are dictated by the standards set for home broadcasting. It is possible, however, to build far better television cameras and associated equipment, including video recorders, which will produce results closely approximating those obtained by direct photography on 35-mm film.

Within a year such equipment will be available to the motion picture producer. This will enable him to use all the television techniques to produce electronic motion pictures whose quality, when transmitted over the commercial broadcast channels, will exceed that presently available from the best live talent productions.

Design personnel at this Laboratory are about to introduce a higher resolution television system. The need for this is well recognized in the field of theater television. Present broadcast standards of four megacycles are insufficient to meet the requirements of large-screen projection in the theater. The new cameras and associated equipment will produce pictures which are nearly twice as good as present-day broadcast images. When such images are recorded on equally good video recording equipment, the resulting motion picture film will approximate the quality of 35-mm original photography.

How then, will this transition to electronic motion picture production be made? It will probably occur in several different ways. The first successes will come to those who are already experimenting with high-speed motion picture production methods, like Vidicam. They will adapt quickly and easily to the new technique. They are practically there already. By the addition of a video recorder, a continuous rapid processor and a projector it is now possible to expand the Vidicam system to produce an "answer" sound print which the sponsor can have immediately for approval and review. Such a system for audition work and rehearsal "rushes" can be the most economical short-cut to fast production. If high-quality television cameras are used with Vidicam systems, the day will soon come when the electronic recording will suffice for most purposes—for telecasting, review and nontheatrical distribution.

The armed services are also a factor in this area. Always alert to any method for producing training films in less time, the Navy Photographic Center recently made a test film using television equipment supplied by this Laboratory. This experiment is the subject of the paper by Lt. Comdr. J. S. Leffen in this issue of the JOURNAL. It is only necessary to state here that the experiment was successful: a 20-minute training film was produced in fourteen hours of camera time. Experience would cut that figure appreciably.

At the Navy Special Devices Center, experimentation with the effectiveness of television for education has been going on since 1946. To better study the results of experimental programs kinescope recording facilities were installed at the Center. As a part of the competitive testing of live classroom instruction versus live television training, a test of the kinescope recordings was also conducted. This latter phase proved that the recordings had nearly the same impact as the live television performance. It soon became apparent that the kinescope recordings were a very valuable end product in themselves. They were used extensively in training. This work led to the experiment at the Naval Photographic Center, the results of which you have seen.

Hollywood producers in the larger companies will probably arrive at this electronic motion picture technique by another route. When the motion picture theaters begin to exploit theater television extensively, they will look to Hollywood to supply the material to transmit to the theater, just as they have always looked to Hollywood for screen fare. To meet these requirements, the major studios will undoubtedly install

television equipment and begin to gain the necessary experience with the technical phases of the television medium so that they can bring to bear the full force of their artistic achievement. In meeting this need, there will be many times when it will be more efficient and expeditious to produce these theater television epics during the day rather than at the particular time required by the theater schedule. So these programs will be recorded by high-quality video recording apparatus and played into the circuit at the appropriate screen time. At this point, or before, Hollywood will be in the thick of producing electronic movies and will have become so skilled in these techniques that networks will be vying with one another to buy such a product. The age of the electronic motion picture will have been born. The motion picture and the television industries will have moved many steps closer together. This is, of course, essential for the continued growth of each.

As the television medium assumes its full national stature and becomes a broadcasting industry of greater scope by far than radio, it will offer a new and tremendous market to the motion picture industry for a suitable product, a market which can be efficiently and successfully met by the adoption of high-speed motion picture techniques and, finally, fully electronic motion picture production techniques.

Practical Operation of a Small Motion Picture Studio

By MORTON H. READ and EUGENE N. BUNTING

The problems and methods of handling television film commercial and short productions economically and in a limited space are outlined.

THE TERM "small" as applied to motion picture production studios is a relative one, and its proper use depends entirely on comparison. I have no idea how the operation of our business compares to the film business in general with the exception of specific cases which are familiar to everyone in the industry. Thus, we are very small as compared to Hollywood theatrical operations, small when compared to the larger and better known of the so-called industrial producers, but perhaps the term "medium" might be applied to our operations when compared to the many organizations which operate on a much smaller scale than do we. So that the reader of this paper may find his own estimate of our size, the following list may be helpful.

1. A sound stage of 3000 sq ft,
2. Camera and lighting facilities including a portable 15-kw field generator,
3. Sound Department, including a 16-mm film recorder, $\frac{1}{4}$-in. and $17\frac{1}{2}$-mm magnetic recorders and phonographs,
4. Printing facilities for black-and-white and color duplicates.
5. 16-Mm black-and-white machine processing,
6. Cutting, editing and screening facilities,
7. Animation facilities, and
8. A production, creative and sales staff, totaling 15 persons.

There is more than one reason why small motion picture studios exist. The reason can be from the standpoint of: (1) economics, (2) efficiency, or (3) business conditions peculiar to a given geographical area. All of these reasons have had an effect upon our growth, the last one most of all.

New England is different from some sections of the country when it comes to spending money. Our clients want quality, but they don't want to pay what they call "fabulous prices" for motion picture production; and, in fact, if New England clients could not buy motion pictures within certain price ranges, they would not buy at all. But in spite of our limitations and conditions imposed upon us, we must produce motion pictures which compare favorably with those produced by almost anyone else in the business.

The increasing number of television productions has made it necessary to add speed without sacrificing quality, a requirement which we feel has added to, rather than subtracted from, efficiency. And so we have developed certain techniques to accomplish what must be done, some new versions of old methods and some new.

Perhaps the most important factor in the successful operation of a small studio is the selection of a staff. This selection may make or break the business because the cost of overhead is the

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Presented on April 30, 1951, at the Society's Convention in New York, by Morton H. Read, President, Bay State Film Productions, 458 Bridge St., Springfield, Mass.

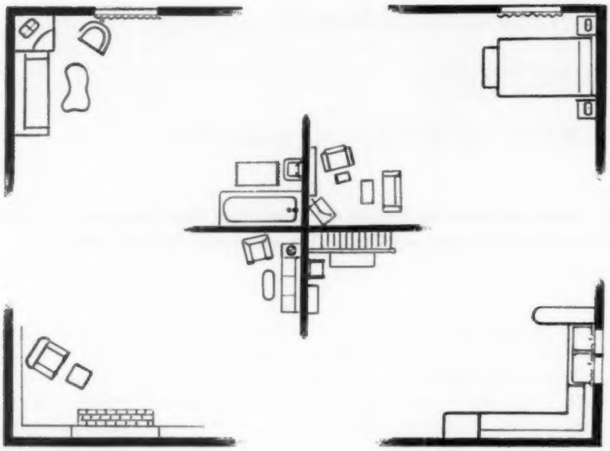

Fig. 1. Studio Arrangement.

greatest single enemy. Wherever possible, it is desirable to select or train men who are capable in more than one phase of production.

There is almost no place for single-job specialists here. To be sure, there will have to be some single-job men such as those in the laboratory who are closely confined to their work; but our three cameramen must also do lighting, animation, editing, matching, cutting and splicing. Our sound engineer must also be the recordist, do musical scoring and maintain the equipment. For that matter, anyone who elects to spend his business life in a small motion picture studio, must plan to do many different operations. Some might think that such a set-up makes for inefficiency and chaos, but there is advantage in close cooperation and integration, which make possible a follow-through well nigh impossible in any other type of organization.

Set design in a small studio can be something of a problem, especially if it is necessary to have several sets ready at the same time. When budgets are low and space is limited, casts cannot be kept on subsistence while sets are changed and the studio is rearranged. This is especially true when a series of television commercials involves (as they often do) a kitchen, dining room, living room, hallway with front door, etc. If the studio can be completely set up in advance with all top lighting in place, it's possible to do a vast amount of work in a minimum of time.

Studio Arrangement

Figure 1 illustrates a type of studio arrangement which is probably not original, but which we have not seen elsewhere. It provides four fairly sizable, two-wall sets and four smaller two-wall sets. The four corners of the studio are used for kitchen, bedroom, dining room, living room, etc., while the unit in the center will handle a small bathroom, a hallway, doorway room corner, etc. This center unit is rather interesting since it is designed to fold flat and can be wheeled out of the way on a small dolly. This arrangement would not work too well for production demanding three-wall sets, but it works to great advantage in television and allows complete use of the entire sound stage. In planning a shooting schedule, it will be found more efficient to complete scenes in the center

section first, then roll that section out of the way for work on the corner sets.

Many small producers have made a practice of doing television work on location and, in isolated cases, such a procedure may work to advantage. In our experience, however, it is always preferable to work in the studio where every phase of production is under control.

Production techniques in small studios are, of course, based on standard practices worked out by the experts. Almost everyone who does not possess facilities for manufacture or development, buys his entire equipment packaged and ready to use. But it would require a lot more money than the usual small producer has, to own everything he will require to accomplish the great variety of demands which will be made upon him. It is then that his ingenuity must be put to work if he is going to compete. It is then that gimmicks and gadgets make their appearance and equipment begins to do and do well, jobs that were never intended for it. Many Bell & Howell projectors have been modified with synchronous motor drive. Old projector amplifiers are now doing duty as parts of sound readers and many fine old cameras are working again in various versions of an optical printer. The adaptations are not haywire. They are doing a good practical job. The small studio is what it now is because of ingenuity and hard work.

At this point in the Convention presentation there was shown a short portion of a color print, *The Will to Be Remembered*, produced for the Barre Granite Association, Barre, Vt.

Improvisation

There was more than one reason why the print projected was chosen for the meeting. Besides the subject matter, it is a typical example of production in a small motion picture studio. By that, I mean the use of equipment never intended to do the work for which it was made. A small production unit advances slowly in its acquisition of fine cine equipment, but it still must turn out the work.

The print was made on a Depue, double-head, continuous printer operating at 76 ft/min. A resistance light control board was used for varying light intensity and all fades and dissolves were made simply with A&B rolls and cutting the current from the printer lamp. Obviously, with a double-head machine, the sound track was printed in contact, but should it seem that the whole list of taboos for color printing has now been completed, there is one still to come. The re-recording of the voice track was made from a standard, synchronously driven, Bell & Howell projector. No change was made in the optical system although resistance and matching systems were introduced in the projector amplifier output.

This system of re-recording is one we have long since abandoned but, though unorthodox, it can be made to work well. For some time now, we have been using a system of magnetic tape transfer in re-recording. Perhaps this method of tape transfer might be interesting to those who are not blessed with three-phase interlock and all that goes with it. We were using magnetic transfer long before there was any publicity about it and the method is so simple that anyone can use it. Our particular set-up involves a standard Magnecorder, $\frac{1}{4}$-in. tape recorder and a Kinevox $17\frac{1}{2}$-mm magnetic film recorder and phonograph. Since manipulation of the starting switch on the Magnecorder will allow the drive mechanism to operate without transporting tape, it is possible to start and stop the transport at any given time. Our system is to measure the final cut work print of a film and provide the recordist with a copy of the script which has each section of the narration marked off in linear measurement. By refer-

ring to a synchronous footage counter and starting and stopping the Magnecorder as indicated, it is a simple matter to transfer wild narration track to the synchronous magnetic film in just ten minutes per reel. There is no cutting of tape or film track, no bloops to worry about, no worry about the handling of the medium which is to be recorded. If the recordist makes an error, he simply notes it, finishes the reel and then goes back to erase the area where the mistake was made so that he can fill in that particular narration.

There is no controversy between the theoretical and the practical in the small motion picture studio. I feel sure that everyone in the business would be perfectly equipped if he had the choice. But any business must grow and in growing must turn out quality or fall by the wayside; and if survival is the *only* reason, a way will be found to make quality a reality. The small studio has one very great advantage over its larger counterparts. That advantage is a close-knit, compact organization with little or no distance between the man who develops an idea and the man who executes it. We are blessed with a group every one of whom is vitally interested in turning out the best possible job. Since a great many small studios survive and continue to grow, it seems safe to assume that our situation is not peculiar to us.

Most small producers rely on practical methods of control throughout the whole operation. It sounds trite to say that such control is merely the judgment of what looks and sounds good, but in effect that is so. In color work especially, the highly specialized machinery for color analysis is denied the small studio because of cost alone, and some other means must be found to bring about consistent results. A good deal of interest has been expressed in our particular color control methods and although I feel quite sure that they are not greatly different or outstanding, they are outlined below. The methods may prove interesting simply as a means of comparison to those in general use. The basic rules are as follows:

1. Employ as few color correction filters in the printer pack as possible.
2. Careful voltage control of the printer exposure lamps.
3. Standardized test for each stock emulsion number.
4. Standard color patches on each print.

Color Control

The gauge or color patch consists of twelve color patches representing different mixtures of the three basic colors, magenta, cyan and yellow. Because corrections are to be made visually and not by instrument, each patch is a full frame in size. In our opinion, it is important that these patches are not pure basic colors, since if they were, small contamination by an odd color would not be easily detected. These color patches are made up of 50–50 mixtures of cyan–yellow, yellow–magenta, magenta–cyan and certain deviations from the 50–50 mixtures. We find that these patches reveal errors that may be quite small. [Slide projected here.] The patches at the top of the slide are the original ones shot in the camera; those in the center are a set from several hundred which were duplicated in the printer and which are attached to each print; and those at the bottom were cut from a print.

When a stock test or print returns from the laboratory, the color patches are visually compared over a constant light source with the gauge from which it was printed. It would be very unusual to find all patches out of balance, rather than only those most affected by the color which is in the wrong proportion. Thus too much yellow in the filter pack will not greatly affect those patches which are made up of a high percentage of yellow nor will too much magenta greatly affect the magenta patch.

But an excess of magenta, will show up in the green patch causing it to turn brownish by comparison with the original from which it was printed. Similarly, an excess of yellow would be detected in the violet patch by causing it to appear reddish by comparison to the original; and an excess of cyan would be apparent in the yellow patch by a green cast.

It is surprising how this comparison test will show up even minute discrepancies in the color balance. By holding the proper filter of the right density over either the original patch or the printed one, as the case may be, and examining the result over a constant light source, the two gauges can be made to match. It is then easy to judge as to what change in the filter pack should be made. If the original was made to match the print, then a subtraction must be made from the pack, but if the print was made to match the original, the pack will need a filter added to it. Of course, a great deal will depend upon the technician who is handling the matching problem and considerable experience is necessary before consistent results are possible. Even as a cameraman allows his judgment to influence his exposures regardless of meter readings, so must the lab man make his decisions in the light of his past experiences. The system works very well in our laboratory and should certainly operate elsewhere with the same good reliability.

Production for Television

Even the smallest studio outside of metropolitan areas will find that sooner or later it must have some type of machine processing for black-and-white films if it is going to make television deadlines. There is no adequate processing service in New England and we found much of our profit being disbursed in messenger fees, plane fares and 'phone calls—not to mention the wear and tear on the nervous system. A simple, but very efficient processing machine for negative and positive processing is made by the Bridgmatic Company and we have found ours very satisfactory for the volume of work we have to do. Later models of this machine have incorporated a number of advantages including refrigeration units for cooling, but ours is the simplest model employing four 10-gal tanks, a dry box and a trouble-free film transport system. The machine has its limitations, of course, but with proper handling it does a fine job. For cooling we installed a window air conditioner controlled by a room thermostat and our processing quarters are small enough to keep everything, including solutions, at the proper temperature. For heating, pieces of Calrod strip were attached to the tanks which are also controlled by thermostat. We did find it desirable to increase the strength of the average hypo solutions about one and a half times to obtain complete clearing. When processing certain emulsions such as Eastman Kodak negative 5230 and 5240, even this intensified hypo solution fails to do a good job of clearing if more than 4000 ft of film has been processed in it; in which case, hypo is also used in the short stop tank.

Our particular machine uses steel, rubber-coated tanks and we have found it desirable to recoat them every six months with Du Pont Fairprene cement.

The problems of the small motion picture studio and laboratory might well seem unsolvable to those who have gone many years beyond that stage of development, but I am sure that men and women who have been through the early stages, no matter where they find themselves today, will sympathize and appreciate what is being done in small quarters all over the country. Only those who have been set down in the midst of all the highly specialized machinery, the glory of the motion picture business today, may find us hard to understand. However, the small producer is here, I am sure, to stay.

Direct-Reading Light Flux Meter

By G. GAGLIARDI and A. T. WILLIAMS

The meter described in this article will measure the total lumens output of the projector and, by means of aperture plates, the light distribution over the screen. These measurements are taken by holding the meter directly in front of the projection lens. The "off" projector can be checked and adjusted just prior to use.

DURING THE PAST ten or fifteen years considerable work has been done by the Society to obtain satisfactory meters which would measure screen illumination and brightness. Theoretically, the problem is not difficult but in practice the resulting meters are either too difficult to use or too expensive to be practical. This is particularly true in the case of a satisfactory brightness meter. Several satisfactory illumination meters have been described and used. In the March 1948 JOURNAL the Screen Brightness Committee recommended a procedure of measuring the illumination by means of a visually corrected foot-candle meter. This procedure necessitated taking illumination measurements at five points on the screen and from these five foot-candle values a weighted average is calculated which, when multiplied by the effective screen area, in square feet, equals the lumens on the screen. This procedure often entails the use of extension poles in connection with the photocell targets or the use of ladders and precarious climbing on the part of the observer in order to reach the center and top of the screens. Some of the screens in drive-in theaters are so large that balloons have been used to lift the photocell to the high spots on the screen. At best it is a long procedure and one that can be done only during off hours. In drive-in theaters it can be done only after the last show because of the high ambient light at any other time.

The new instrument, described later, was developed to measure the total light output of any projection system, and the side and center illumination, without leaving the projection room. All of these measurements can be obtained readily and quickly during show time and without causing any interruptions. The measurements are taken under actual operating conditions and include working parts, filters, lenses and shutters.

Presented on May 2, 1951, at the Society's Convention at New York, by G. Gagliardi, Warner Brothers Theaters, Newark, N.J., and A. T. Williams, Weston Electrical Instrument Corp., Newark 5, N.J.

Light Flux Meter

The Light Flux Meter shown in Fig. 1 consists of three basic parts: the integrating chamber which contains the photocell, the meter mounted in a case containing the selector switch and

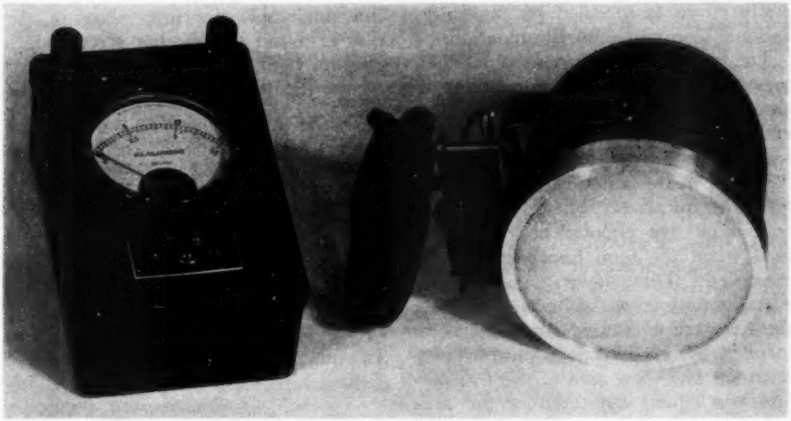

Fig. 1. Light Flux Meter.

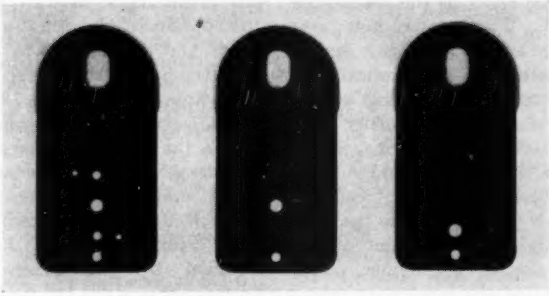

Fig. 2. Aperture plates.

attentuating resistors, and a series of aperture plates to measure both total lumens and light distribution on the screen. All of these values can be measured in the projection room.

The integrating chamber should theoretically be a large sphere with a small aperture but this is impractical for this application because such a sphere would be unwieldy and would not fit in front of the projectors in many booths. The integrating chamber used in this design actually consists of a hemisphere having an inside diameter of approximately 4 in. and a short cylindrical tube which joins the hemisphere with the two diffusing glass windows. The inside surface of the hemisphere and tube is coated with a lacquer having a white matte finish which produces excellent light diffusion. The location of the photocell and proper baffling to prevent direct light from striking it were carefully worked out with the result that the errors due to using various sizes of projection lenses are quite negligible.

The photocell is a dry disc barrier-layer cell and is equipped with a filter which corrects it to the standard lumi-

nosity curve as specified by the International Committee on Illumination.

The meter is a permanent magnet, movable coil type of microammeter having two scales calibrated 0.0 to 15.0 and 0.0 to 7.5 kilolumens. A selector switch allows the choice of either range.

The aperture plates, shown in Fig. 2, serve two purposes. The aperture plate containing five circular perforations is used when the total lumens are to be measured. These holes are located in such positions on the plate as to simulate the five screen reading method recommended by the Screen Brightness Committee. The total area of the five perforations equals one-tenth of the area of a standard film aperture. The individual area of each perforation was graded in an attempt to give them the same weighting effect as the committee recommended. The center hole was made twice the area of one side hole and four times the area of one corner hole. In addition to the weighting effect, the aperture plate, because of its 10% transmission, reduces the temperature to safe values on the lens and on the integrating chamber and photocell.

A single-hole plate is used to measure the relative light at the center of the screen and similar single-hole plates with the holes at the corners or edges can be used to measure the relative light values at other corresponding areas of the screen. These readings can be used to indicate relative illumination values, or the foot-candles can be readily computed by means of a simple formula. For example, if we make the hole diameter on each single-hole plate such that the area of the hole is 5% of the total area of the film aperture then the light intensity on any screen can be calculated. The light intensity, or foot-candles (I) will be a function of the screen size but since the ratio of screen height and screen width is a constant the screen areas will be proportional to the screen width squared (W^2). By measuring the lumens output (L) with the single-hole aperture plate in the film gate and the effective screen width (W) the light intensity can be calculated by the following formula

$$\text{Foot-candles} = \frac{2.74L}{W^2}$$

In the above formula a 5% area plate was assumed. If it is desired to round out the formula then instead of using a 0.1775-in. hole, which is the 5% area size, the hole diameter can be decreased to 0.1697 in. which will have 4.58% of the total area of the film aperture. In this case the formula will be as follows:

$$\text{Foot-candles} = \frac{3L}{W^2}$$

Fifteen theaters were surveyed using this Light Flux Meter. Values were also obtained by using a foot-candle meter and calculations as described in the Report of the Screen Brightness Committee in the March 1948 JOURNAL. Based on tests both in the laboratory and in the field with lenses of different focal lengths and different speeds, it was found that the maximum difference between the values obtained with the Light Flux Meter and the procedure specified by the Screen Brightness Committee was 8% but that the average was better than $\pm 5\%$.

The advantages of the Light Flux Meter may be summarized as follows:

1. All measurements can be made in the projection room.
2. Measurements can be made during the performance on the "off" machine without interrupting the show.
3. Adjustments can be made simultaneously with the measurements.
4. Comparative measurements can be made quickly when any item of the equipment is changed.
5. Check-up for peak performance may be made as often as desired without any extra expense or inconvenience.
6. No external or internal source of power is required to operate the meter.

Discussion

K. Pestrecov: Is the instrument available commercially?

A. T. Williams: Unfortunately, it is not available. Our company is so tied up with war work that I doubt we could make one up. However, it is possible that some smaller company may take over the development and we are willing to turn over the design and the data that we have to some company that may do that. Mr. Gagliardi is working on that now. We would be glad to lend the instrument out for a reasonable time to anyone who wishes to do experimental work with it. We merely made this up in answer to a demand, but unfortunately, we are not in a position to manufacture it.

W. W. Lozier: The Screen Brightness Committee would be glad to accept that offer and use the meter. Is there any way of taking into account the effect of the screen? That is the one link we lack after we have the incident illumination.

Mr. Williams: No, unfortunately this does not consider the reflectivity or the polar characteristics of the screen surface. We merely measure the incident illumination.

R. H. Heacock: Is it put out in front of the projection lens?

Mr. Williams: That is right. It is used right in the booth, and is put over the front of the projection lens.

H. J. Benham: It would seem to me that the image would have to fill rather exactly the space that you had set aside to correspond to the projector aperture. Does that mean then that you move this device back and forth until you get it the exact size that fills the space you indicated on your little mask?

Mr. Williams: No, the instrument is put directly in front of the lens. The mask is placed in the projector aperture itself, and therefore limits and defines the light passed on to the lens and the meter. Use of the integrating sphere enables the instrument to integrate correctly the intensities of the light beam irrespective of whether the projection lens has a focal length of $2\frac{1}{2}$ in., 3 in. or 5 in., for example.

Dr. Lozier: It will integrate a small cross-section beam as well as a large one within the diameter of the pickup element.

L. Martin: I imagine a useful application of this meter might be the balancing of two or more projectors so that uniform brightness is obtained when you change over from one to the other. Was it Mr. Gagliardi's intention to provide a meter that would be in continuous use during the show to keep the projectors properly balanced? Did your tests indicate why there are discrepancies in light output between projectors?

G. Gagliardi: We have actually used it during the show in many instances. It is possible to take a series of readings from any projector at the end of a reel, after a change-over has been made. Only a few minutes are required for the readings, and possible adjustments, so that all projectors can be balanced without causing any interruptions.

This instrument could be used continuously or at periodic intervals in order to check the balance between projectors as well as their maximum output. Tests in the field indicated that most of our machines were fairly well balanced. Discrepancies between projectors were usually traced to changes in carbon position or in relative position between lamphouse reflector and projector aperture plate.

In the shop or in the factory, where we made a lot of other tests, we were able to detect small differences in readings, depending upon carbon position, reflector position, changes in lenses and reflectors, and general equipment alignment. In other words, it was possible to tune the system to maximum output without looking at the screen, merely by looking at the meter.

The choice of scale is something that can be determined later. We chose 7500 and 15,000 lm because those values seem to be the mean and maximum output of the present projection systems with the shutters running. That is another thing you can determine: whether the shutter is set at 50% transmission, or more or less. All of these things can be measured at your own convenience in the projection room if you wish to do so, or they can be measured anywhere else for that matter.

I know that in actual operation the readings of light intensity taken at the screen have varied widely. In order to get a decent average it may be necessary to repeat a set of five measurements several

times and average them, because you cannot depend on one reading alone. The new meter integrates and totalizes all the readings at once, so that the changes in the total value of light flux may be followed very readily. It is possible to follow the variation in light flux as the carbons are moved by the arc feed mechanism.

Mr. Martin: Mr. Gagliardi's answer would indicate this is more a laboratory instrument for the initial adjustment of the projector than an instrument to be used constantly in the projection room in order to keep the projectors in balance during the performance.

Mr. Gagliardi: I don't think that in most of our theaters you need to check the projectors between each 20-min operation. However, you can use it as often as you please.

Mr. Martin: I wasn't proposing that you do. I just wondered whether your measurements indicated any need for it or not, and I think you've answered my question.

L. W. Davee: I have followed the work that Mr. Gagliardi has been doing for several years and I think that this instrument is the culmination of one of the finest pieces of work which has been presented before this Society or in this industry for a number of years. I have been a very enthusiastic supporter of this development. This is not a piece of laboratory equipment. I believe it is a piece of equipment to be used by every equipment salesman and every dealer and every serviceman. I have nothing to do with selling these devices; I have no connection with them. I believe that the use of this meter, in other words the widespread use of this meter, will take some of the fallacies out of some of the sales stories a lot of salesmen in this country use in selling projection equipment, and I, for one, would like to see this meter adopted very, very widely. It would serve as a basis for comparison, it would standardize our industry, it would make our industry the type of industry I would like to see. As projector manufacturers, we would welcome such a piece of equipment on the market today so that we could come down to a basis for comparison of relative values of the equipment that is now offered to the theaters.

New Processing-Machine Film Spool for Use With Either 35-Mm or 16-Mm Film

By F. L. BRAY

It was decided that a new film processing machine at Du Art Film Laboratories, Inc., should be capable of handling either 16-mm or 35-mm film. After a number of experiments to find the best sprocket and spool combination, a radically new type of spool distinguished by a tapered profile was chosen. The advantages of this design, as applied to sprocket-drive and friction-drive machines, are enumerated.

When it was decided that the new 35-mm developing machine being built at Du Art Film Laboratories should, if at all possible, be capable of processing 16-mm film interchangeably with the standard width, the general lines and type of design had already been established.

This machine was to have some 58 spool banks of a type that is quite orthodox for a sprocket-drive machine. The top shaft is driven, and with it the film sprocket. The film spools on the top shaft are not secured to the shaft, but do have a tendency to rotate at the same speed as the shaft. The lower spools are all as free as possible on their shaft, and the carriage on which they are mounted is free to move straight up and down, but in no other manner. The weight of this carriage is supported entirely by the loops of film, which are thus kept in suitable tension regardless of the swelling and shrinking of the film as it progresses through the stages of processing and drying.

Tentative Approaches

The first thought, probably, that would occur to anybody with this problem (of designing a dual-purpose processing machine) would be something like Fig. 1A. It would be easy enough to recess the 16-mm portion of the sprocket deeply enough so that 35-mm film would bridge the 16-mm teeth with plenty of clearance. Of course the two kinds of film will travel at different linear speeds, but since all spools are idlers they will run at whatever rotational speed is required of them.

The technique of changing over from 35-mm to 16-mm involves the use of an unperforated strip of machine leader tapered in width from 35-mm to 16-mm over a length of several feet. This is run through the machine slowly to make sure that the change-over is successfully accomplished. From the first we were willing to accept this step as practically unavoidable.

Now, referring to the spool-sprocket combination of Fig. 1A, we should note

Presented on April 30, 1951, at the Society's Convention at New York, by F. L. Bray, Du Art Film Laboratories, Inc., 245 West 55 St., New York 19, N. Y.

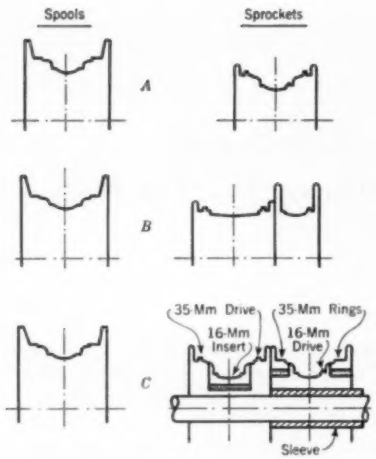

Figure 1.

that one serious difficulty threatened. In making a change-over, say from 35-mm to 16-mm, would not the film break immediately, due to the failure of the 16-mm sprocket to feed film as fast as it is demanded by the 35-mm sprocket ahead? No; actually the elevator would rise until the change-over is completed for that particular film bank. Moreover, a little analysis shows that the elevator rise would be exactly proportional to the reduction in linear film speed, with the result that the processing time remains unchanged. Of course, had this arrangement been adopted the productive capacity of the machine for 16-mm film would have been some 25% less, in feet per minute, than for the 35-mm size, and this might or might not have been regarded as a serious matter.

The elimination of this elevator rise (or drop on going back to 35-mm film) might have been accomplished by using two sprockets having as nearly as possible the same pitch diameter, as shown in Fig. 1B. This would have required manually lifting the film from one sprocket to the other as the tapered change-over strip reached each successive pair. This operation would entail no great hardship, but would still take quite a long time to accomplish when, as in this particular case, the machine was to carry some 7000 ft of film.

It is not easy, nor would it be worth while, to recall all the proposals that were put forward and subsequently rejected. One of the more fanciful is shown in Fig. 1C. Here the idea was to have a pair of sprockets at the middle of each top spool shaft. One, the 35-mm driver, would be secured to the shaft, and contain a free-turning 16-mm insert without teeth. The other sprocket would be the 16-mm driver and would be fastened to a sleeve. This sprocket would in turn have had a pair of free-turning 35-mm rings. The sleeve was to be rotated slightly faster than the shaft, by means of a small speed-change gearbox at the end of each shaft, in order that both sizes of film should travel at the same linear speed. By this complex device it was hoped that all the time lost in making a change-over might be saved.

An Old Problem

During the foregoing period of concentration on sprocket design it was assumed that the spool would have to look about like those shown in Fig. 1, which are all the same. Now an ideal spool for 16-mm sound film seems never to have been made; so at about this point we began considering what kind of a compromise might be least objectionable for the 16-mm insert portion of our new combined spool. It is well-known that even very slight abrasions of the film base in the sound-track area can add noticeably to the ground-noise level of a 16-mm sound track. Therefore what was sought in the 16-mm profile of this new spool was a minimum of support on the sound-track side—that support to consist of soft rubber in contact with the very edge of the film base.

Accordingly the idea illustrated in Fig. 2A was tried—but it simply would not work. For when there was any con-

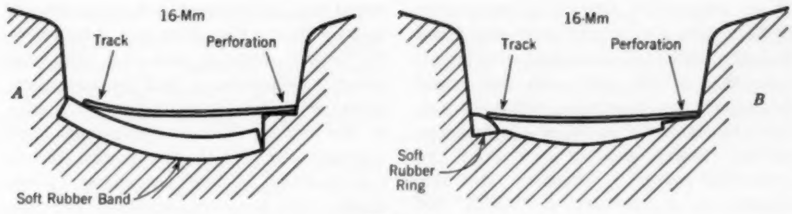

Figure 2.

tact at all on the sound-track side, the film would be drawn up the steep rubber slope until it was almost entirely supported on the sound track alone! This effect was conceived to be the same as that which causes a flat power transmission belt to seek the high side of a pulley—a principle that was subsequently turned to good account.

The next proposal for a 16-mm profile is shown in Fig. 2B. This soon had to be abandoned due to the difficulty of procuring the necessary quarter-round soft rubber in ring form.

Toward a Solution

About this time it became apparent that the whole idea of a composite spool with two different diameters might give a lot of trouble. In changing over from 16-mm to 35-mm, for example, there would inevitably be a series of 18 sharp yanks on the film, each requiring the elevator to rise approximately one-half inch as the film climbed upward and outward from the 16-mm channel to the 35-mm channel of each successive spool. In the opposite direction, changing back from 35-mm to 16-mm it is hard to predict what would happen, except that the operation would most certainly not be a smooth one.

We were familiar with the belief held by some that a level soft rubber surface over the entire width of the spool, such as shown in Fig. 3A, is quite harmless to the support side of motion picture films, since the unit pressure between film and spool is held at a low uniform level in this way. However, because of a desire to eliminate every possible hazard, it was decided to positively relieve the picture area at least, and the sound-track area also if a way could be found.

Equal Diameters, Yet Fully Relieved

Out of all the above considerations and experiences, there finally evolved an entirely new film spool, the profile of which is shown in Fig. 3B. The most characteristic feature of this spool is the taper, which of course is an application

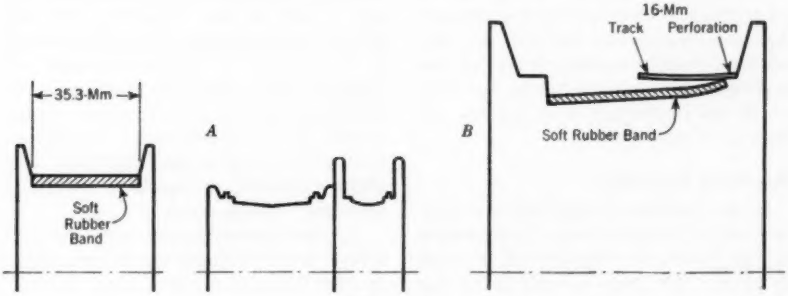

Figure 3.

of the experience described previously. 16-Mm film is threaded over this spool with the perforations toward the "high" side—that is, the side with the larger diameter. In operation, the 16-mm film maintains the shape of a cylindrical surface, making contact only along the perforated margin. Moreover, this film always has a tendency to "climb" toward the high side of the spool until stopped by the guide flange on that side, at which position it is shown in the illustration. 35-Mm film, of course, is carried by this spool in the usual position, resting upon the shoulders on both sides. The 35-mm sound track may be at either side, as it will be fully relieved either way.

While this spool has one apparent weak feature—which will be discussed below—it does meet every one of the objections heretofore encountered. It facilitates 16-mm production at full machine capacity. It fully relieves both the picture and the sound-track areas of 16-mm sound film. And, most important, it eliminates sudden slackness or yanks during change-overs.

The weak feature referred to is that the weight of the lower spool assemblies (elevators) is supported entirely by the perforation part of the 16-mm film strands. While tests have shown that eight or even four strands are ample to carry this load, it has been learned by trial that the presence of any torn perforations in 16-mm sound film must inevitably result in breaks. For an answer it has simply been determined in advance that any 16-mm film fed into this new machine must be completely free of torn perforations. This is a quality standard which is considered well within the capacity of the laboratory.

Operating Procedure

In the interest of simplicity two separate, adjacent sprockets are to be used as in Fig. 3A and the changes will be made by hand. The hope is entertained that the operators will learn to catch the tapered strip as it passes each sprocket pair and to lift the film from one sprocket to the other without reducing machine speed. Otherwise it will be necessary, of course, to fill the machine with leader at the end of 35-mm operations, then change over to 16-mm leader before commencing 16-mm processing. Even in this case, however, thanks to the constant spool diameter, it will be possible to run the machine at full speed during the actual change-over, only stopping momentarily at each sprocket, instead of having to run through 7000 ft at perhaps one-quarter speed.

Design Features

One or two of the details of this particular design may be of interest. The purpose of the increased slope at the high side of the spool is to provide a definite break between the supported portion of the film and the relieved portion. The purpose of the soft rubber band is to provide a low unit pressure supporting surface for any 16-mm film which may temporarily come into contact with the middle portion of the spool. In addition, this soft rubber, because of its relatively high coefficient of friction, assists materially in the steep climb required of the 16-mm film just before it reaches the shoulder on which it normally runs.

The actual amount of taper selected for the spool is four degrees. A simple test showed that this value permitted a misalignment between the supply roll and our test spool of approximately one and a half degrees. That is, with any greater misalignment, 16-mm film started in the middle of the spool would not reliably climb onto the shoulder. An experimental spool having an eight-degree taper was also made, but had an incongruous appearance, and was only slightly superior in regard to ability to overcome misalignment.

Another interesting discovery was that a little more misalignment is permissible at high linear film speeds than at lower ones.

Use With Friction-Drive Machines

This type of film spool may, it is hoped, be particularly applicable to friction-drive processing machines on which it is desired to run different film widths interchangeably.

In the usual friction drive machine, the type of film spool shown in Fig. 1 would be useless since, in changing over between the 35-mm and the 16-mm widths, there are no elevators to compensate for the difference in linear speed through the machine.

Provided that tensile stresses, particularly in the dry cabinet, are held within reasonable limits, there seems to be no reason why any friction-drive processing machine could not be readily designed or converted for satisfactory interchangeable service through the use of this new type of film spool.

Discussion

Gerald Graham: Are these spools on the market? Can you give us any information as to where they can be procured?

Mr. Bray: They can be purchased from either the Luzerne Rubber Co., of Trenton, N.J., or from Du Art Film Laboratories.

Nonphotographic Aspects of Motion Picture Production

By HERBERT MEYER

Motion picture technology is predominantly focused on photographic and other processes for recording action and sound. Few papers[1] have been contributed dealing with other technical activities pursued with commensurate skill, inventiveness and constantly expanding knowledge of materials and processes in Hollywood studios. Set construction and special effects present an amazing variety of problems little known or even suspected by outsiders as concerning motion picture production. This paper attempts a description of materials and techniques applying to set construction and special effects. Emphasis is placed on pointing out present technology, desirable improvements and possible developing trends.

Technically, the motion picture industry is recognized and typed by its predominant and obvious activities in the use of photography as a means of recording and reproducing action and sound. For this reason, other technological aspects which play a large and important part in the process of making a motion picture, are little known or recognized outside the studio.

This paper attempts to point out the many processes and materials which the average motion picture studio employs in activities that are generally grouped within the broad functions of set construction. Considering that the studio, to furnish proper settings for story background, must in the majority of cases construct and fabricate some or all of the sets instead of using existing locales, it becomes immediately apparent that the need for materials and fabricating methods in set construction is virtually unlimited and ever changing.

The Motion Picture Research Council,[2] in recognition of this fact, has spent considerable time and effort in contacting literally hundreds of chemical and allied-material manufacturers and fabricators to obtain guidance and collaboration in finding new useful materials and processes applicable to this multifaced project. This has proved to be mutually beneficial, primarily for the reason that the contacted industries recognized motion picture production, often for the first time, as a potential consumer of many of their products. The studios have profited substantially from these contacts since they provide a wealth of advanced technical information and

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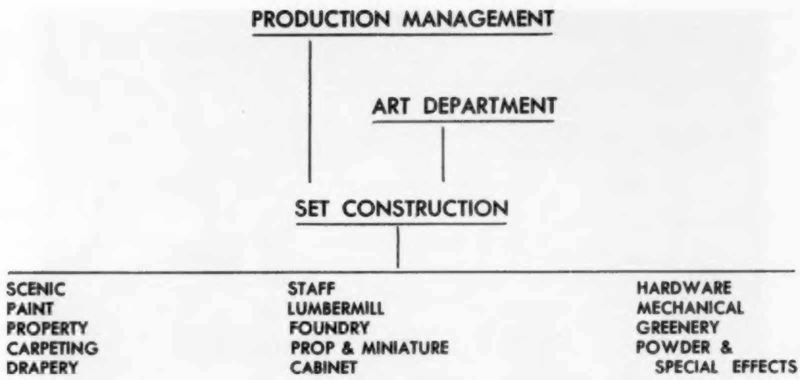

Fig. 1. Material-processing and fabricating shops and subdepartments.

experimental aid contributed by the research laboratories and the highly-developed technical service divisions of practically all those enterprises which were approached.

The set-construction department, to cope with the variety of tasks, has at its disposal an array of material-processing and fabricating shops and subdepartments which form an organized entity, as illustrated in Fig. 1.

An exhaustive description of the functions and activities of each of these shops is not possible within the scope of this paper. Our discussion is restricted, therefore, to a presentation of typical examples. Before proceeding, a few remarks on certain features affecting set-construction operations may assist in better understanding existing conditions and the reasons for their establishment. Proper conception and analysis of these furnish means for recognizing future trends and form a basis for possible development in a desired direction.

The fact that the studios should have to engage in such diversified fields of fabricating as indicated by the departmental setup, appears at first hand somewhat debatable. The economic soundness of operating such shops can be rightfully questioned, assuming that within the large industrial area of Los Angeles there are a great many fabricators who could take care of these requirements and who operate with less overhead than the average studio. It can be shown, however, that the development of such industrial facilities is only of relatively recent date and not yet comparable to that of eastern and midwestern sections of the country.

Another reason for the studios' policy of self-sufficiency in this field is the requirement of immediate availability of set-construction items. Scheduling a motion picture is controlled by many factors which, to a large degree, are not predictable. Changes in schedule are not introduced, as often assumed, by bad planning, but rather by the fact that even with the most careful and experienced preparation, last-minute modifications and delays are practically unavoidable. Production of a motion picture is, of course, a highly technical undertaking, but is interwoven with artistic and human elements which defy orthodox technical treatment. These circumstances necessitate rush orders which, in turn, require immediate availability of fabricating facilities in order to avoid expensive production delays.

Fig. 2. Typical hard flat set.

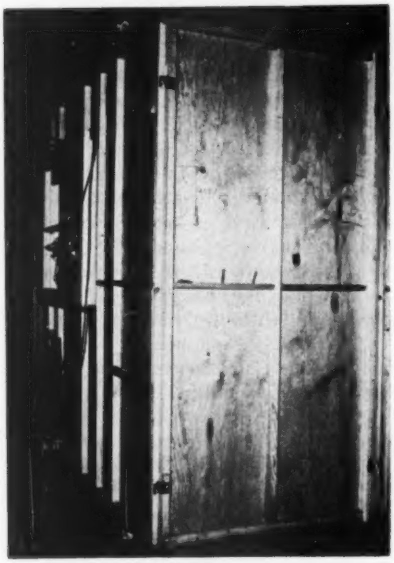

Fig. 3. Rear view of hard flat, corner section, showing structural details.

Furthermore, it is doubtful that outside fabricators could produce some of the properties at a profit within comparative studio costs, since repeat orders are not guaranteed, quantities are small and the fabricated item does not always have a value for other markets.

One may interject that there must be a number of items of repeated usage in set construction which consequently are practically standard in size and shape. An article of this type is the brick-wall unit which is produced in large numbers in studio staff shops. There is little doubt that with industrial advancement a substantial portion of present costly studio operation in fabricating will eventually be entrusted to outside local establishments to mutual advantage.

Following is a description of activities pertaining to set construction. In view of the great variety of materials and of application methods, three main groups were selected:

I. Structural materials for sets and set properties and techniques of application;

II. Materials and methods for surfacing; and

III. Materials and methods for "special effects."

An attempt has been made to cover established practices, recent developments and to indicate trends. It was thought important in this connection also to point out objectives which so far have not been satisfactorily reached.

Part I. Structural Materials for Sets and Set Properties and Techniques of Application

Wood Products

Lumber, presswood and composition-type materials such as plywood, masonite, fiberboards and similar products, are used in considerable quantity. A typical structural unit to be found in studio set construction is the so-called "flat." Two types of flats, both used for interior walls, are practically standard items.

One, called "hard flat," is made of a multiple plywood surface backed by a wooden frame and bracings (Figs. 2, 3 and 4). It serves as a wall unit of great durability, which is reused over and over again. It is fabricated up to sizes of 4 × 12 ft and is fairly heavy.

The other type, called "soft flat" (Figs. 5 and 6), is composed of a light wooden frame over which is tightly stretched a muslin-type fabric. It was introduced originally by requests of the sound engineers for wall materials of less density than the plywood-surfaced flats.

Both types have their specific advantages and disadvantages. The present trend, which favors hard flats, is due in large measure to the successful introduction of the Peel Paste[2] technique with its improved method of recovering and resurfacing plywood flats.

There is a definite interest in an improved hard flat, lighter in weight and more resistant to scuffing than plywood. It should be free from warpage, reasonably weather resistant and permit nailing. The ideal would be a board material exhibiting all these properties, and, in addition, having sufficient strength and bulk to be used as a wall unit without requiring heavy bracings.

Plaster Casting and Staff Shop

Plaster-type materials are used in very large quantities and for a great variety of fabricating purposes. The low price of the raw materials and the simplicity of fabrication methods which may be performed without exacting and expensive mechanical equipment have made plaster casting a most important part of set-construction activities. Modern cost analysis of studio operations, however, has revealed that the excessive weight of plaster casts, which translates itself into high costs for transportation, supporting structures and rigging, causes plaster to be a highly expensive operational item. Low chip resistance, brittleness and poor weathering properties are also on the debit side.

This has prompted the search for lighter-weight materials of greater mechanical endurance, which has resulted in the introduction of plastics in direct replacement of plaster, as described in a later section.

Many direct efforts have been made to eliminate the shortcomings of standard plaster casts, aimed at improvement of plaster materials as well as fabrication methods.

Casting-plasters of highly increased tensile and impact strength, such as calcined plaster and melamine-compounded types, have not found appreciable recognition due to their much greater material cost. Art plaster, a dextrine-gypsum-type material, has been accepted for its

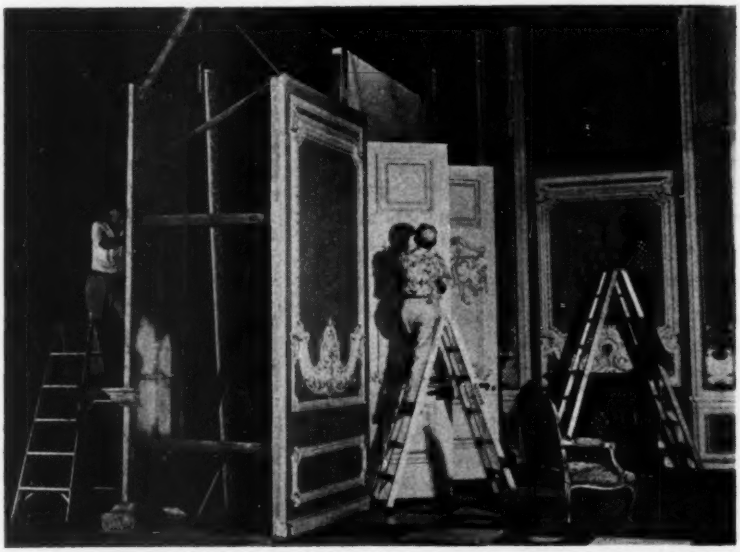

Fig. 4. Construction of hard flat set. Front surface of set walls presents intricate ornamental patterns obtained by novel plaster casting technique.

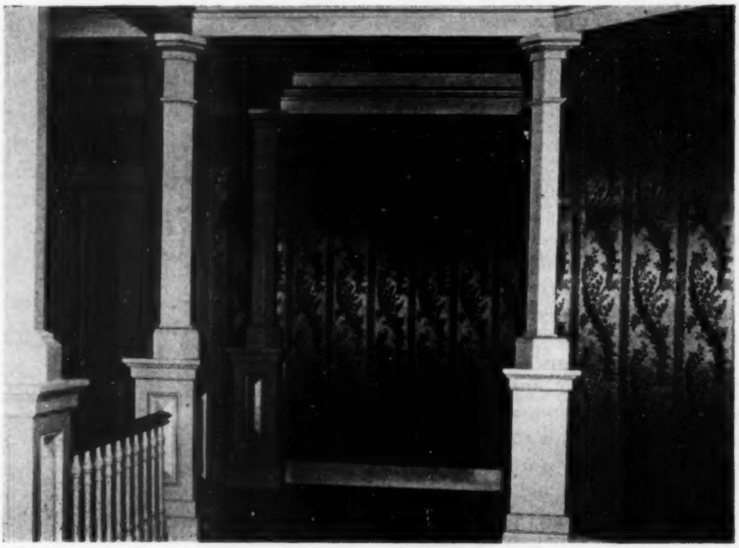

Fig. 5. Typical soft flat set.

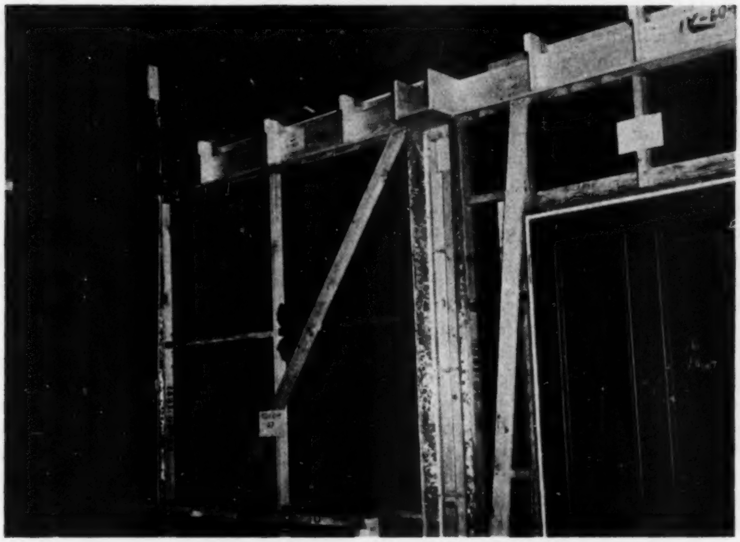

Fig. 6. Soft flat unit. Same as Fig. 5. rear view.

Fig. 7. Arch cast from urea-formaldehyde-reinforced plaster.

noticeably better mechanical properties (except sensitivity to humidity), since it is available at only a fractional increase in cost per pound.

Recently, the studios have found excellent use for urea–formaldehyde-fortified plaster. In the present form of application, this resin and the required catalyst are added in water solution to the plaster slurry. The greater tensile and impact strength of the resulting plaster is utilized in several ways: it permits thinner casts, which means reduction in weight; it has also been found suitable for replacing expensive wooden moldings, such as are required for the curved parts of Roman- or Gothic-type window frames; it has become a preferred material for building cornices, stairway steps and other structural units which may be exposed to excessive scuffing, marring or wear of any type (see Fig. 7).

However, the hardening of plaster through admixture of urea–formaldehyde is only effective to a certain degree. It was found that the hardening effect is practically confined to the surface of the plaster cast and that inside portions remain unchanged. This is probably due to the fact that the gypsum in the process of setting squeezes the yet unreacted urea–formaldehyde solution toward the surface. The setting of the urea–formaldehyde to a resin apparently takes place later. It is, no doubt, induced by the increase in temperature resulting from the exothermic reaction of plaster setting.

A more uniform hardening effect can be obtained by considerably increasing the amount of urea–formaldehyde added to the plaster slurry. However, this raises the material cost to an objectionable degree.

Fig. 8. Rough-surfaced stone slab, spray-cast from mixture of chopped glass fibers and plaster slurry by Paralite process.

Fig. 9. Rock column made from glass fiber-reinforced polyesters. Brick wall and stone wall units fabricated from same material.

Studies aimed at keeping the urea-formaldehyde more uniformly distributed in the plaster cast through addition of water-soluble gums or cellulosic ethers show promising results.

Hardening of plaster does not satisfactorily increase chip or crack resistance. Recent experimental work in this direction has produced improved plaster modifications through incorporation of film-forming emulsions of polyvinyl, methacrylate, polystyrene and copolymer types.

The reinforcement of plaster with fibers is generally practiced. Plant fiber, such as sisal, has been replaced in some studios by glass fiber, while others consider the higher cost and the irritating effects of glass fiber dust with disfavor.

An ingenious method of spraying plaster slurry together with short chopped glass fiber into molds, using a specially designed double-spray gun, has been developed by one of the studios. It is most advantageously applied in fabricating large objects such as rocks, brick-wall paneling and other structural items, since it permits reduction of cross section and, consequently, weight, without sacrificing strength (Fig. 8).

Mold Materials

The flexible polyvinyl-type mold has, in several studios, practically taken over the function of the glue mold for plaster castings due to its superiority in toughness, flexibility, inertness to humidity change and other properties. It also is replacing increasingly the rigid plaster mold except when relatively very large castings are being made. Here the difference in price of the mold materials and the ease of fabricating the mold may still favor plaster. So far, the thermoplastic-type polyvinyl rubber is practically unchallenged, in spite of the fact that it requires a rather critical process of heating, melting and pouring. The thermosetting type of material available for making flexible molds, such as thiocol rubber which can be worked at room temperature, is considerably higher priced and cannot be reused, so that mold failures are total losses.

Plastics and Related Materials for Structural Use

Thermosetting Compounds—Polyester Contact Resins. The most significant change that has recently affected the established routine of studio staff work was brought about through the introduction and acceptance of polyester contact resins. These compounds, activated by catalysts and accelerators, set up and cure at room temperature to yield rigid or flexible shapes of extreme mechanical strength and excellent detail fidelity. They have, so far, most closely answered the need of the studios for suitable light-

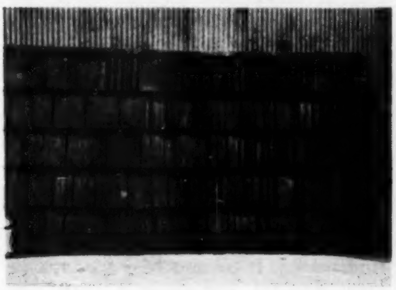

Fig. 10. Roofing shingles cast in unit of approximately 4 ft x 6 ft, made from glass fiber-reinforced polyesters.

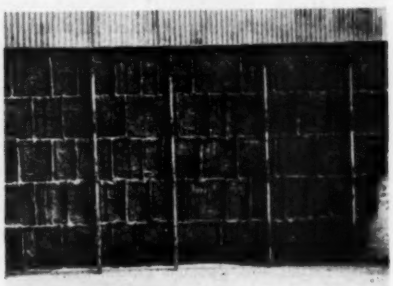

Fig. 11. Same as Fig. 10, rear view.

weight structural materials. The general technique by which they are employed consists of a casting-laminating process which combines glass-fiber mats with the resin in rigid plaster or flexible molds. Final curing to tack-free surfaces is obtained by exposing the cast to sunlight or through short heat cycles in temperature-controlled ovens. The exceptional impact and tensile strength of these casts makes it possible to reduce their thickness to a fraction of that required for plaster casts. This results in substantial savings in transporting, erecting and striking, so that in spite of the comparatively high material cost of polyester–styrene resins, their use has been constantly increasing (Figs. 9, 10 and 11).

Desirable Improvements in Polyester Contact Resins. Desirable improvements to extend the application range of these types of materials for studio work are expected in the following directions:

(a) Development of lower-priced resins: It is conceivable that progress in fully understanding the reaction mechanism of cross-linking polymers will extend the presently restricted number of relatively expensive unsaturated chemical compounds, such as alkyd types, to include less costly components possibly capable of forming thermosetting resins under proper conditions. Particular attention is pointed to the potential usability of the various unsaturated residues obtained in refining petroleum crudes. They are inexpensive and abundantly available. They form thermoplastic, low-molecular polymers when heated in presence of oxygen without appreciable loss of double bonds. Being usually of dark color limits their application in many fields. This would not, however, prohibit their extended use as structural materials in studio work, provided a simple reaction process could be developed to change them into thermosetting compounds.

(b) Development of fire-resistant-type polyesters: Although flameproof resins are commercially available, or treatments to reduce the flammability of standard types have been suggested, none of these are entirely satisfactory so far as studio experience has shown. Improvements in this direction would open additional avenues of application for these materials.

(c) Improved parting agents for flexible molds: Since monomer styrene attacks polyvinyl chloride-type mold materials, particularly at elevated temperatures, difficulties are encountered in the use of such molds for polyester–styrene casts and laminates.

(d) Development of spray technique for polyester resins: Spray techniques are being used by a number of commercial fabricators, such as boat builders. A thoroughly satisfactory method has, so far, not been developed for application to studio work. The two principal difficulties concern the control of the catalyzed resin to avoid premature gelling in the gun and in the mold, and the poor wetting properties of glass fiber which prevent satisfactory penetration of the resin into the fiber mat.

(e) Colorless, transparent casting resin of low shrinkage: Requests for such a material have long been voiced in various fabricating fields. There is a definite, although limited, need for studio application.

Miscellaneous Recent Developments in Thermosetting Plastics. Of possible substantial importance appears to be the recent advance in producing cold-setting phenolics. Their properties are sufficiently different and distinct from those of polyesters that they should find many uses to good advantage. At this point, however, practical experience is yet insufficient for their full evaluation.

A unique product employing polyester constituents has been successfully introduced for application in prop and miniature work. It consists of a special-type clay material impregnated with precatalyzed polyester–styrene. This compound can be hand formed or modeled since it has claylike properties, and can be

set and cured to a tough, rigid material by exposure to heat.

Glass-fiber sheaths impregnated with precatalyzed polyester–styrene are known to the studios. Their use has, however, not been extensive.

The recent commercial appearance of polyesters in solid form which are formulated by the user through the simple process of dissolving the solid in monomer styrene, is decidedly interesting. The advantages offered in safer storage and choice of formulation should make these resin types a welcome addition to the ones available as ready-to-use polyester–styrene liquids.

Thermoplastic Compounds. The variety of materials belonging to this group does not lend itself to simple classification. Materials such as waxes have to be included although they may not belong, by chemical structure, to the group of plastics produced by polymerization. Some of these materials are employed in fabrication methods making use of their thermoplasticity, others are not. In the first instance, their thermoplastic properties are a direct advantage, while in the second case this property is either ignored or presents even a disadvantage rather than an advantage.

Of the many materials used quite extensively by the studios, the following were selected as examples:

(a) Waxes: Natural and synthetic waxes have been found to offer unique properties in the fabricating of a number of different studio properties. Their peculiar translucency and surface reflectivity make them ideal for imitation of objects which depend upon these specific qualities for convincing photographic reproduction. The ease with which waxes can be colored or pigmented is another favorable quality.

An outstanding field of potential application, not yet fully exploited, is that of marble imitation. It is repeated for emphasis that adaptability of materials for studio work depends not, in the final end, upon visual, but on photographic judgment. There is no material known comparable to waxes which conveys, in photographic reproduction, equally the peculiar, complex impression of marble as it is stored in our memory. Fairly satisfactory marble effects are frequently obtained through surfacing objects such as walls or panels with a marble-patterned paper, which is a simple and inexpensive process. This becomes, however, quite difficult when the surface of the object is of a compound shape or if the object has fine ornamental details and undercuts. Certain types of columns are good examples in this respect. Casts made of white microcrystalline wax, impregnated with dyes and pigments for imitation of veins and irregular strata, produce most striking effects.

Different techniques for fortifying waxes to increase tensile and impact strength, through adding small percentages of ethylcellulose, low polymer-type polyethylene and other ingredients, make it entirely feasible to consider waxes for much more general structural use in competition with the already discussed thermosetting materials. Such modified wax materials are already successfully employed by commercial fabricators in the manufacture of window-display models, dolls and ornamental figurines. They can be used as such, or in combination with reinforcing materials such as fiberglas. A unique process for such purposes is slush molding, wherein the molten wax is poured into a closed female mold. After pouring back the excess, a hollow cast remains. The wall thickness of the cast can be controlled through adjustment of the pouring temperature.

The relative flammability of wax materials presents a serious hazard during the process stage and in the finished product. The necessity of pouring the material at high temperatures contributes, in addition, to the dangei of occupational hazards.

(b) Thermoplastics for hot-drawing techniques: This standard process,

which requires only a minimum of simple and inexpensive equipment, is favored in studio prop and miniature shops for fabrication of a variety of items. Among these are helmets, armors and similar historical commodities. The imitation of the required metallic properties is accomplished through surface treatment. In film productions of stories with a medieval historical background, availability of this process presents a highly appreciated contribution to economy and, not least, to comfort for the wearer due to the lightness in weight.

Thermoplastic sheet materials, used for hot drawing technique, are methacrylates, ethyl cellulose and cellulose acetate. Cellulose triacetate, recast from photographic film waste, and extruded cellulose acetate butyrate sheets are also presently under consideration.

(c) Cellulosic materials specialties: A commercially available, highly porous material in sheet form, consisting of cotton flannel impregnated with cellulose nitrate and a fire retardant, has been found quite useful for fabrication of lightweight articles such as boat hulls, cylinders, shells, tubes, guns and clubs. The original dry material is impregnated with a solvent and becomes entirely flaccid. In this condition it can be readily formed around or in a variety of regular or irregular shapes. Upon evaporation of the solvent, the material becomes rigid, retaining the shape formed during the molding operation.

Similarly, it is possible to impregnate plain felt, gauze or paper with a solution of cellulosic materials and to obtain a practically equivalent result.

Due to the fire hazards involved, suggestions have been made to replace the cellulosic components with polyvinyl resins. Some of the recently-tested formulations appear to work satisfactorily.

(d) Cellulosic materials for translucent screens: The use of cellulose acetate and ethyl cellulose in the fabrication of large seamless sheets of up to 30 × 36 ft for background process screens, and of even considerably larger sizes for translucent scenic backings, are rather ingenious developments that originated in Hollywood studios. Such sheets are fabricated by hand spraying a carefully blended mixture of cellulosic materials, plasticizers and solvents of varying volatility against a resin-impregnated canvas sheet serving as a matrix. This matrix is normally mounted overhead in a horizontal position. The spray operation is continued until a sheet of sufficient uniform thickness is obtained. The finished sheet is stripped off the matrix and mounted with uniform tension onto a vertical frame. The required diffusion is obtained by hand spraying the sheet surfaces with a similarly formulated cellulosic dope, as was used for making the sheet, to which suitable diffusing agents, such as zinc stearate, silica gel or others are added in uniform dispersion.

(e) Use of other plastic materials: From this report so far, it becomes evident that the predominant use of plastics and other materials for structural purposes in a broader sense, centers in the fabrication of rigid articles and units. This accounts for the relatively small employment of vinyl-type materials in this field.

Fabrication of flexible commodities is mainly represented by sponge and foam rubber. Some of the studios have fully equipped facilities for processing such materials and have excellent knowledge in formulation and handling.

The technique of using Plastisols has not yet found entry into studio shops. Cost of materials, initial equipment and operations are considered fairly prohibitive, since the studios are not concerned with mass production. Artificial plants and leaves are now commercially produced from polyvinyls by a Plastisol technique. Such a process, if applicable to the manufacture of bulk foliage, would be of extreme importance and interest to this industry (Fig. 12).

Cold slush molding, using natural rubber latex and porous (plaster) molds,

Fig. 12. Plastic plants and foliage fabricated from polyvinyl Plastisols.

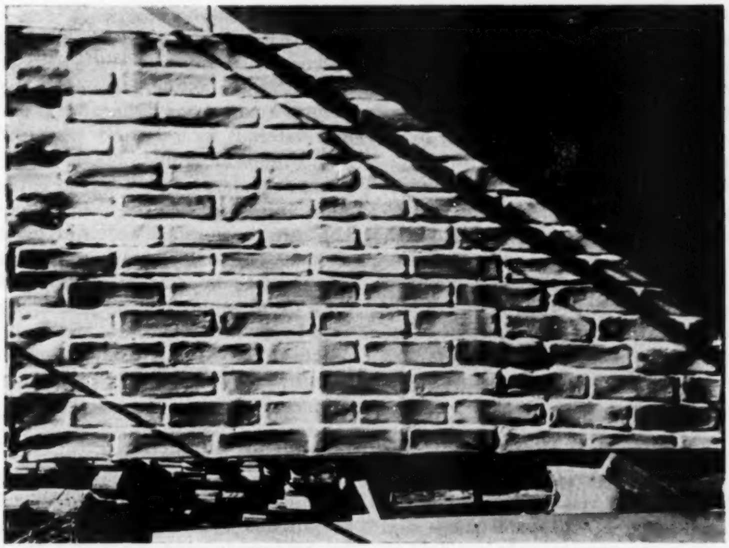

Fig. 13. Unfinished brick wall made from "Thermold."

has, so far, not gained much notice, although it appears a well-suited process for studio application due to its simplicity and the fact that through varying the amount of clay fillers, lightweight articles ranging from flexible to rigid can be produced.

An important and unique use of polyethylene resin is in the construction of compound-shape stair-rail easements. The stair rail is first cast straight. By reheating selected parts to about 250 F, they can be bent and set to any desired shape.

Development Trends in Thermoplastic Materials.

(1) Thermoplastics, so far, have not been seriously considered or used as components in bulk structural materials. This possibility appears quite intriguing for the reason that a number of such materials, like asphalts, petroleum resins and pitches from various sources, are amply available at low cost. The fact that thermoplastics can be reused or reshaped are added inviting properties.

Their greatest deficiencies lie in lack of tensile strength and in their high brittleness which those exhibit that possess a softening point sufficiently high for studio requirements.

It appears possible that these undesirable properties can be sufficiently overcome through compounding with a relatively small percentage of rubber-type materials. It may be practical to fabricate sheets of varying stiffness through impregnation of textiles and other supporting materials with these modified thermoplastic compounds or to obtain them in calendering operations. One commercially available product of this type, although not known in composition, has found use in the making of lightweight, brick-faced wall units (Fig. 13). This material is supplied in rolls. When heated to an approximate temperature of 140 F, it becomes sufficiently pliable to respond to hand or low-pressure molding. Upon cooling, the molded material will regain its rigidity. The original commercial function of this material is to serve in the fabrication of dress forms which can be molded directly by hand over the human body due to the relatively low temperature required.

It should not be assumed from the above that thermoplastic materials are considered a cure-all for the solution of the many structural material problems confronting this industry. However, an open-minded approach to the possibilities and advantages these materials unquestionably offer may pay considerable dividends. It should be kept in mind that deficiencies in certain properties, which would condemn such materials for permanent structures, may not eliminate their usability for temporary structures in studio work.

(2) An entirely novel approach, the practicability of which still awaits considerably more testing, suggests the use of unsupported polyvinyl sheetings as building materials for relatively large props and structural units. These could be cut in accordance with designed patterns and joined by a heat sealing technique. For use, the finished article is inflated with air. The advantages offered are low weight and ease of transportation since props of this type can be deflated. This technique would also, of course, be practical only for a limited range of structural set items.

Part II. Materials and Methods for Surfacing

The activities related to this subject are performed by the paint shops and the scenic departments. It is a field in which the well-known techniques of brushing, spraying, dipping and troweling are applied with a variety of materials for ornamental and functional use too large to be described in detail.

It includes oil- and water-base paints for outdoor and interior use, varnishes, lacquers, sealers, primers, thinners, solvents, protective coatings, flameproofing compositions, water repellents, flatting agents, pigments and fillers, surface-active agents, antistatic agents, wood preservatives, specialty coatings such as multicolor paints and skidproof paints, metallizing paints, conductive coatings, heat-absorbing and reflecting coatings, peelable coatings, adhesives, putties and caulking compounds, paint removers, floor maintenance compounds, cleaning compounds and a host of others.

This general classification should suffice to convey an impression of the variety of materials belonging to the broad fields of surface treatment in which the motion picture industry is interested.

Each paint shop has ample facilities for testing the constant flow of new commercial products to stay abreast of the rapid technical developments in all branches of interest.

While it is not intended to describe surfacing materials and techniques in any detail, a brief consideration of some rather unique studio applications may be of interest.

Outdoor Backings

To the standard implements of studio facilities belong large rectangular-shaped pools which permit staging of any kind of water scene on the studio lot. The proper pictorial background, whether horizon and sky with cloud effects or other suitable scenery, is furnished by a hand-painted backing. The supporting structure for this painted backing is a wall made of plaster, concrete or wood. It presents a smooth, plain surface facing the pool. The background scenery is either painted directly onto this surface or the surface is first covered with canvas to which the paint is then applied. Outdoor backings of this type are made up to sizes of 60 ft in height and 300 ft in length (Fig. 14).

Surface coatings and paints suitable for this specific application require a high degree of weathering resistance. The use of polyvinyl derivatives which, when incorporated in a water-base paint, are capable of forming a tough, continuous film upon drying, has been recognized as an excellent means of preventing cracking and chipping of painted backings, even under prolonged exposure.

Foliage Treatment

The studio demand on cut branches or foliage for scenic effects is extremely large. Wilting and drying not only cause problems of fire hazards, but also necessitate continuous costly replacements.

Two practical methods have been developed and are in use, both capable of preserving foliage for repeated use and of rendering it effectively flameproof.

One is a treatment by which the foliage is impregnated with a concentrated solution of calcium chloride in large studio-designed vessels under application of vacuum and pressure (Fig. 15). The treated foliage loses its natural color, which is artificially replaced by means of spray painting with a coating containing a suitable dye and a flame retardant.

In the other method, the foliage is simply hand sprayed with a formulation of natural rubber latex to which pigments and flame-retardant fillers have been added.

Both methods have proved satisfactory in reducing fire hazard and preventing drooping and wilting effects on leaves and branches by supplying a type of mechanical support to the treated foliage.

Developments and Trends

Modified phenolics formulated as sealers and top coatings have been found most useful for stage-floor maintenance and as protective coatings on plywood surfaces.

Fig. 14. Outdoor backing with built foreground set.

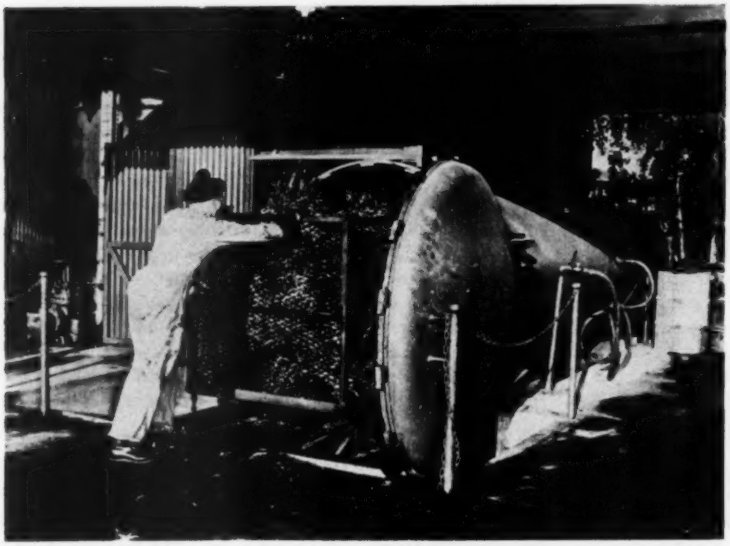

Fig. 15. Plant and equipment for preserving and flameproofing natural cut foliage.

Hot spray lacquers are being tested for the advantages they offer in yielding heavier coatings.

A trend toward water-base, latex-type paints is becoming quite evident and has just recently received considerable acceleration through the introduction of several polyvinyl-type products of greatly improved flow characteristics, stability and hiding properties.

Part III. Materials and Methods for "Special Effects"

Studio terminology combines under "Special Effects" a large variety of items, materials, equipment and processes which, selected and developed, sometimes with amazing ingenuity, aid in realistically imitating natural phenomena for photographic reproduction which otherwise could be considered only at prohibitive expense or with impossible hazards. Some of the effects described belong to prop and miniature shop activities or those performed by the staff shop.

The special effects department is constantly confronted with requests for the apparently impossible and actually creates new effects almost in every day's work. It is, therefore, possible to discuss only a number of those effects which have become standard parts of motion picture practice. Since this paper is written primarily from the viewpoint of one interested in materials, the purely mechanical phase of this field will also be omitted. It should, however, be mentioned here that the efforts and merits of the special effects departments in engineering developments are outstanding in quality and quantity. Wind and wave machines, rain-producing equipment, explosive devices, instruments for any conceivable sound effect and innumerable other means for producing specific phenomena in any wanted strength and modification give ample testimony to the inventiveness and mechanical skill of those engaged.

Fog Effects

In producing fog effects, the potential scope of fog-producing reactions, materials and processes is considerably limited since toxic and corrosive ingredients are prohibited. Other factors reducing the choice of materials are odor, lacrimating and otherwise irritating effects on personnel, and attacking properties on paints, lacquers, textiles and the like.

The most desired qualifications for fog effects are high volume, density, stability and, partly related, ease of stratification.

The studios differentiate between chemical and other fogs. Chemical fogs are mainly those obtained by the interaction of amines and acids, but also included are titanium chloride, sulfuric anhydride and other hydrolyzable compounds. They are known to produce fogs of ideal density, so far not obtainable with any of the other materials. Corrosive properties, however, restrict them to occasional outdoor use.

Oil fogs are most frequently used, although their density and stability are not too satisfactory except where large-size generators are employed. Oil fog is produced by studio-designed equipment, based on either atomizing oils selected from suitable petroleum fractions at room temperature or on vaporizing the oil by heating it to the required temperature. The latter process is quite superior where fogs of large volume and density are required. It may be engineered by the simple use of electric hot plates or with complicated heat guns from which the oil is ejected by air pressure through nozzles after passing an arrangement of heat coils. Natural and dry ice are employed to increase density and stability of the formed fog cloud.

Developments in this field are aimed at improved equipment and simplification of producing methods. Recent

Fig. 16. Interior stage set with dress snow using crushed rock.

Fig. 17. Interior stage set with dress snow using silica gel.

experimentation with emulsified oils is quite promising. Investigation of humectants, such as glycol derivatives, with incorporation of inorganic salts such as ammonium chloride, point to other interesting material sources.

Smoke Effects

It is probably surprising to learn that a completely satisfactory method of producing black smoke is still not available or known to the studios. Of the two methods most frequently employed, one consists of the use of commercially available smoke candles. These usually contain hexachloroethane, among other ingredients, and are disliked due to odor and corrosiveness of the smoke by-products.

The other method makes use of a mixture of diesel oil with 30 to 40% carbon tetrachloride which is ignited in open vessels. The function of the carbon tetrachloride is to induce and maintain conditions favoring incomplete combustion. Attempts to replace carbon tetrachloride with organic halogen derivatives of similar functional properties, but yielding less toxic decomposition products, have so far failed.

A limited, but occasionally pressing demand exists for colored smokes. Commercial smoke candles are available for this purpose but their performance is quite poor. Further research in aerosol technique, although so far not successful, may yet lead to better methods.

Indications are that military basic research undertaken during the last war has advanced the knowledge of conditions under which controllable fogs and smokes can be produced to a remarkable degree. Much of this work still awaits declassification.[3]

Snow Effects

Artificial snow for studio use has two distinct classifications. One includes materials useful for dressing stage or location sets with snow effects which are accordingly known as "dress snow." The other applies to material suitable for the imitation of falling snowflakes, which consequently is termed "falling snow."

Materials for falling snow have to be fairly light, fluffy and of a particle size not less than $\frac{3}{8}$ in. to properly convey photographically the impression of falling or drifting snowflakes.

The same type of material used for falling snow may also be satisfactory for dress snow. However, dress-snow materials generally consist of heavier, crystalline, salt-type compounds such as gypsum, rock salt and the like (Fig. 16).

A recent interesting development concerning dress snow is a method by which a solution of sodium silicate and of a mildly acidic or alkaline compound is brought together to form silica gel in a reaction chamber consisting of an elongated cylindrical tube. The silica gel is extruded at the far end of the tube and chopped into snowlike fragments by a propeller blade. This process produces dress snow continuously. The equipment is mounted on a carriage which permits the dressing of sets and locations with a minimum of manual labor. This snow material is particularly capable of rendering realistic footprints and wheel tracks (Fig. 17).

Another material, also lending itself to satisfactory rendition of snow impressions, is so-called "snow plaster" which has been in use by the studios as dress snow material for a long time. This product is specially produced casting plaster to which blowing agents have been added which are activated as soon as the plaster slurry is mixed. The resulting cast is a highly fluffy product which can be broken, crushed and powdered on fairly light impact.

The oldest-known stand-by for falling snow material is a special type of cornflakes. They are either thrown by hand into the air current of fans or sifted from overhead through sieves onto the stage. Rubber foam, feathers, heating of metaldehyde, perlite, etc., have also been used more or less successfully for this.

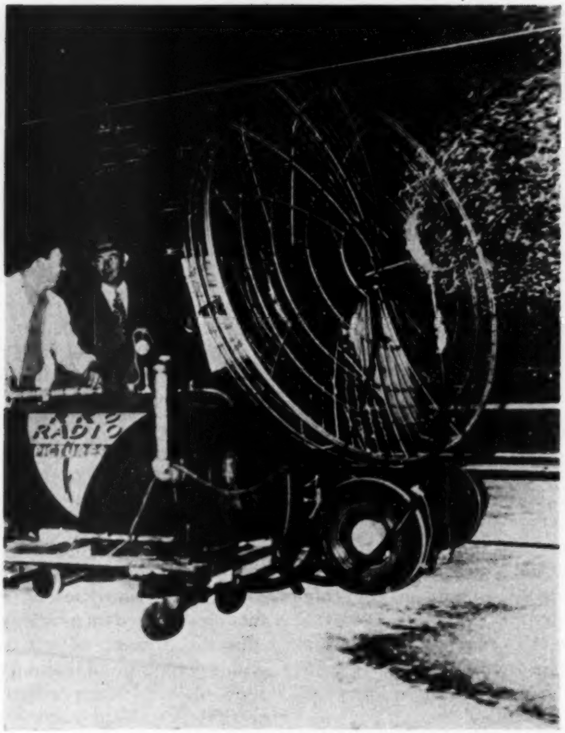

Fig. 18. Equipment for producing falling snow with foaming agents.

A novel process of great merit developed in one of the Hollywood studios utilizes foaming agents in concentrated solutions such as have been employed in fire-fighting equipment. The solution is ejected in continuous operation through a rotating perforated drum mounted centrally in front of a large fan. The foam is propelled in controllable flake size over a relatively large area. Modification of fan speed permits a wide range of phenomena from light or dense plain snowing to blinding snow storms (Fig. 18).

The snow dressing of trees, slanting surfaces, window sills and the like requires, with present methods, a large amount of manual effort and is, therefore, quite costly. A flocking procedure in some form, with suitable flock materials, may be a future answer to this problem.

In general, it can be stated that considerable savings would result if more suitable mechanical equipment for snow dressing and equally for removal of dress snow were available.

As far as snow materials are concerned, none of the presently used compounds are entirely satisfactory. Color photography prohibits the use of impure salt materials. Some of the compounds affect clothing, paints and lacquers. Again, others lack stability in storage or while being exposed to outdoor weather conditions.

Cobwebbing Effects

Spider-web imitation, a frequent scenic requisite for mystery-type stories is usually accomplished by spraying rubber cements using spray guns or special equipment with rotating ejectors for spinning the thread. Careful formulation is required to obtain realistic effects. Reasonable stability and nonflammability of the formed web are desirable. Solutions of polyvinylidene chloride appear best suited. A quick solvent release through proper selection of solvents minimizes fire hazards.

Breakaway Materials

This designation is applied to structural materials which, due to light weight, brittleness and other selective properties can be fabricated into fight props, such as clubs, sticks, gun butts, bottles and furniture and which on impact break easily without causing pain or injury. Such materials are also useful in the construction of buildings, walls and any type of structural unit which, in line with the story, collapses on the actors as the apparent result of catastrophies such as earthquakes, shipwrecks, bombings, etc.

A further frequent use of this type of material is for the realistic replacement of window glass and mirrors. The hero or the villain involved in a barroom fight of an action-filled Western thriller may then endure safely the experience of being hurtled bodily through such props.

The use of balsa wood for breakaway opaque objects dates back to the beginning of the motion picture industry. However, this material is quite expensive and is limited to typical woodworking operations. Plaster extended with lightweight fillers such as vermiculite, perlite and ground Styrofoam has the advantage of being workable in molds. Foamed plaster, like the snow-plaster material mentioned earlier, is used more extensively.

Just recently, commercially available gypsum, with a foaming agent added, has been found to permit the fabrication of porous, low-density molds particularly suitable for metal casting. The plaster slurry is beaten with a disc-like stirrer blade to entrain air and cause foam which can be made to consist of a very large number of bubbles of small, practically uniform size, evenly distributed through the slurry. Depending upon the amount of air entrained, the resulting cast exhibits different degrees of density. This material is also useful for casting breakaway props.

Various plastic compositions capable of being foamed in place have been tested without, however, so far finding suitable materials or processes. The only materials of proven reliability during the processing stage are the arylisocyanates, which are, at present, out of practical reach due to their high cost. Developments in this field of foamed plastics are eagerly awaited by this industry as their potential usefulness in many applications is well realized.

"Breakaway glass" can be made from a number of plastics, all thermoplastic by nature. The properties of these special compounds are quite tricky and include particularly a grade of brittleness which renders the material practically useless for any other fabricating purpose.

Breakaway glass props (Fig. 19) are made by slush molding or casting. The resins used should be preferably water white and transparent. The pour point should not be higher than 275 F; the softening point not less than 100 to 125 F. The resin must be free from cold-flow tendencies. It has to be friable and should readily break into fragments with completely dull edges.

An ideal resin for this purpose was a specialty product manufactured by internally plasticizing styrene with isoprene during the process of polymerization (reversed rubber type). Unfortunately, this material is not produced any more for the present. Other materials quite

Fig. 19. Breakaway glass props.

useful are special phenolic resins, arylsulfonamide–formaldehyde resins and a low polymerized styrene type plasticized with Aroclor.

In instances where presence of color is not prohibitive (colored bottle glass), rosin can be used as an inexpensive, readily available material.

The casting of panels serving as windowpanes is accomplished by pouring the resinous melt onto a sheet of cellophane fastened to a wooden frame. The heat of the resin, upon contact, causes the cellophane to shrink and to furnish a taut, wrinkle-free surface. Cellophane, well known as a mold-release agent, permits safe separation of the highly breakable cast from its support. One studio uses liquid mercury as a casting surface. Some of the liquid fluorohydrocarbons of high specific gravity and chemical inertness have proved experimentally useful for this purpose.

The report given in the foregoing is by necessity sketchy. It has also been unavoidable to omit a number of other departments and their important and interesting activities and to by-pass development work in various phases of motion picture production of a nonphotographic nature which this industry continuously performs. It is intended to cover some of these neglected subjects in a later paper.

The following list of estimated average yearly requirements of the Hollywood motion picture industry on some of the materials discussed may be of general interest:

Plaster of Paris		3,000 tons
Casting plaster	85%	
Art plaster (plaster plus dextrin)	10%	
Hard wall plaster (calcined or resin additives)	5%	
Fiberglas		25 tons
Natural fibers (mainly sisal)		50 tons
Paint thinners		40,000 gal
Shellac		40,000 gal
Lacquer thinners		35,000 gal
Paint lacquers		11,000 gal
Flat paints—oil base		32,000 gal
Flat paints—water base		15,000 gal
Paint enamels		6,000 gal
Varnishes		4,000 gal
Whiting and titanox		20 tons
Earth pigments and dry colors		95 tons

Oil putty	6 tons
Spackling putty	6 tons
Denatured alcohol	40,000 gal
Turpentine	10,000 gal
Linseed oil	2,500 gal
Carbon tetrachloride	7,000 gal
Acetone	2,000 gal
Kerosene	10,000 gal
Stearic acid	2 tons
Floor wax—liquid	3,000 gal
Floor wax—paste	3,000 gal
Floor-cleaning compounds	25 tons
Soap and detergents	17 tons
Bronze powders	2 tons
Mold glue (gelatin)	10 tons
Flexible mold materials (polyvinyl derivatives)	25 tons
Polyester-type plastics	75 tons
Lumber	20,000,000 board ft
Plywood	2,000,000 sq ft
Presswood	2,000,000 sq ft
Fiberboard	2,000,000 sq ft
Textiles for backdrops, cycloramas, etc. (canvas, cheesecloth, etc.)	2,000,000 sq ft
Textiles for diffusion cloth (canvas, denim, nylon, etc.)	500,000 sq ft

According to the 1948–1949 *Motion Picture Almanac*, there are 276 different industries, arts and professions involved in the making of a feature. This same source lists the costs of "sets and other physical properties" for an average production budget as representing 35% of the total production cost.

The *Film Daily Year Book 1950* publishes a figure of $62,874,000 covering Hollywood's 1949 bill for supplies, including maintenance costs.

These few statistical estimates and facts may directly and indirectly sustain the statements made in the introductory part of this paper emphasizing the importance and the extent of the nonphotographic phases of motion picture production.

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Improved Kodachrome Sound Quality With Supersonic Bias Technique

By JAMES A. LARSEN

By simultaneous application of signal frequencies, d-c noise reduction bias and "supersonic" a-c bias to a variable-density light valve, it is possible to make direct recordings or electrical prints on Kodachrome with very low intermodulation distortion. This technique permits the use of a higher transmission with a resulting increase in sound output of at least 6 db.

Electrical printing of Kodachrome sound tracks without the use of high-frequency bias has been commercially available—at least, on the West Coast—for about two years. Intermodulation recordings made under these conditions indicated that for a modulation level at 80% of clash,* the intermodulation distortion was relatively high—in the vicinity of 50% at densities that gave a usable volume. The reason that acceptable recordings were possible under such high intermodulation distortion was that the recording level was kept down allowing only an occasional peak to reach into the 80% or higher modulation level. This, of course, limited the level that it was possible to put on the Kodachrome electrical print.

The advantages of "electrical printing" or re-recording printing of 16-mm sound tracks have been pointed out in an article by John G. Frayne.[1] Another article by C. R. Keith and V. Pagliarulo[2] pointed out the advantages of using a high-frequency a-c bias in making black-and-white release prints using a direct-positive variable-density track.

The method described herewith is a modification of the above-described methods of electrical printing and high-frequency bias direct-positive variable-density recording. In the present application, a high-frequency (24-kc) bias is applied simultaneously with signal frequencies and d-c noise-reduction bias to a variable-density light valve in the production of a Kodachrome sound track.

This method produces Kodachrome prints having a higher output level and a greatly reduced intermodulation distortion of about 8%. This is equivalent to a harmonic distortion of approximately 2%. In addition, greater density latitude or processing tolerance is obtained.

The reason for the high intermodulation distortion in the old electrical printing process without high-frequency bias and its reduction by the new method

Presented on May 4, 1951, at the Society's Convention in New York, by James A. Larsen, Academy Films, P.O. Box 3088, Hollywood, Calif.

*Clash is the signal level into the light valve at which the light-valve ribbons just touch, or cross if they are not coplanar.

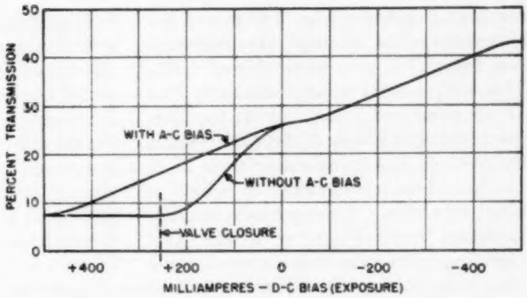

Fig. 1. Transmission-exposure curves.

using high-frequency bias can be seen by a study of the transmission-exposure curves shown in Fig. 1. In the lower curve, the large "hump" or lack of straightness is obvious. The straighter this curve, the better will be the reproduction of sound and the lower the intermodulation distortion. The application of 24-kc bias to the light-valve ribbons at approximately 200% modulation level has the effect of straightening out this curve of transmission vs. exposure as shown in the upper curve of Fig. 1. The large hump is removed and the remaining curve is nearly straight. Under these conditions, intermodulation distortion (at the same level of audio modulation, namely 80%, and at the same density of the unmodulated track without noise reduction) was reduced from a value of 56% without 24-kc bias to a value of about 8% with 24-kc bias. This very large reduction in intermodulation distortion is due entirely to the straightening out of the transmission-exposure curve of Fig. 1. Comparative listening tests on musical recordings made with and without a-c bias confirm the results anticipated by study of the transmission-exposure curves and the intermodulation curves of Fig. 2.

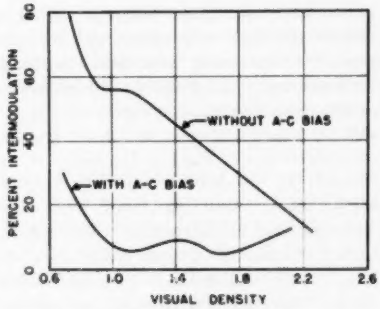

Fig. 2. Intermodulation curves.

It was found desirable to reduce the spacing of the light valve from the standard spacing (for 16-mm valves) of 1.0 mil to 0.5 mil. Since the light valve resonates or is most sensitive to frequencies between 8,000 and 9,000 cycles, it takes a large voltage of 24 kc to drive the light-valve ribbons to 200% modulation. Approximately 12 v of 24 kc was required. The 24-kc signal was obtained from a standard Model 200-A Hewlett-Packard audio oscillator. The 24-kc level is set by measuring the output voltage of the oscillator with a vacuum-tube voltmeter, once the relation between per cent modulation and voltage has been established.

When the light-valve ribbons are modulated 200% by the high-frequency bias, considerably more d-c bias is required to produce a given amount of noise reduction. The d-c bias must be sufficient so that, for silent passages, the light-valve ribbons are overlapped to the point where the peak amplitude of the 200% modulation of the high-frequency bias slightly opens the ribbons. Referring to Fig. 1, it will be noted that with-

out high-frequency bias, 250 ma of d-c bias reduces the average film transmission from 27% to a minimum of 7.5%. This is equivalent to approximately 10.2 db of noise reduction. With high-frequency bias, 250 ma of d-c bias reduces the average film transmission from 27 to 16.5%. This is equivalent to 4.3 db of noise reduction. Consequently, in order to obtain 10 db of noise reduction when high-frequency bias is being used, a d-c bias of approximately 450 ma would be required.

The two principal advantages of this method of electrical printing with a 24-kc bias over previous electrical printing methods are: (1) greatly reduced intermodulation distortion as shown in Fig. 2; and (2) a large increase in volume from a variable-density track. In fact, it is possible to produce a variable-density track, using 24-kc bias, with very low intermodulation distortion and with a higher volume level than from a standard, fully modulated variable-area track. Another less obvious advantage is the much greater latitude of Kodachrome densities possible when using this method. If an arbitrary value of 10% intermodulation for an 80% modulation level is accepted as a practical operating condition, then the density range over which the intermodulation is 10% or less is between a visual density of 0.95 to 1.90 (in the unmodulated area without noise reduction). In other words, any Kodachrome density between 0.95 and 1.90 will give a track with less than 10% intermodulation. Of course, the density of 0.95 will give much greater volume than the 1.9 density and is therefore to be preferred. The relation between intermodulation distortion and per cent total harmonic distortion is approximately 4:1, so that 10% intermodulation distortion equals about 2.5% total harmonic distortion which is considered very good from a 16-mm Kodachrome film reproduction.

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Tape Transport Theory and Speed Control

By J. R. MONTGOMERY

Absolute speed control can be achieved only with a fixed or recorded reference. Reasons include physical properties of tape and mechanical properties of tape transport. If tape properties can be accepted as they exist, the mechanical theories of tape transport must be thoroughly investigated. This paper is a résumé of the pertinent and sometimes little understood phenomena of tape transport and a report of the limits which these theories have achieved in practice.

IN THE LONG HISTORY of man's attempts to record the sounds he hears no problem has required more intensive research or provoked more discussion in technical circles than the efforts to control both the instantaneous and long-term speed of the recording medium. The requirements of the radio broadcast industry created the impetus necessary to numbers of manufacturers and engineers who succeeded, after concerted efforts, in designing transcription turntables of sufficient quality to satisfy the minimum requirements of the broadcasters. The problems of rotating a surface at uniform speed were serious enough to evoke the wholehearted efforts of many of our highest-caliber scientists.

Until a very few years ago most efforts to develop magnetic recording were conducted abroad. Indeed, most early, American tape recorder designs could be traced generically to the German "Magnetophon." The magnetic recording art captured the imagination of a segment of our engineering profession, but even more so, of our general population. As a result of this interest and the fact that the medium itself was no more perfected than the equipment necessary to utilize it, the pressure for production caused hurried engineering and, in too many cases, insufficient research into the underlying theories of tape transport.

The last two years have seen a shift toward sounder engineering. The properties of the medium are now stabilized and, for the most part, understood. Standards of measurement and dimension are more nearly established. The medium is accepted for use in its logical applications with general enthusiasm. Now we find ourselves in a position of having to return to a more fundamental philosophy of engineering to solve certain problems which have been clouded from view by the necessities of satisfying the initial demand for equipment. One of the greatest problems, as first presented by the broadcast industry and, of late, by the requirements of telemetering and other special applications, has been that old bugaboo *speed control*. This becomes understandable when one considers the proportionate numbers of moving parts in a magnetic recorder as compared

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with a disc recorder or playback table. One additional factor not seriously considered by most designers was the concept of tape as an elastic medium.

The general term *speed control* actually includes both long-period timing and instantaneous speed variations known as "wow" and "flutter." One of the odd facets of magnetic recording is the seeming ease with which moderate flutter can be produced. The methods necessary to idealize this performance are much more elusive. Speed control is relative to tolerances. The only known methods of controlling tape timing to milliseconds are by use of a fixed or recorded reference such as a recorded signal to operate a selsyn or other form of control over machine speed. If these tolerances are required, such complex and expensive methods are probably the best solution available today. If the tolerances required are not closer than plus or minus a tenth of a second, the problem may be solved by purely mechanical methods, giving due consideration to the properties of the various recording tapes and their limitations.

The analysis of design theories and problems in magnetic tape recording may be arbitrarily divided into the following categories:

The Recording Medium,
Capstan Drive,
Tape Supply,
Pressure Pads—Pro and Con,
Take-up Design, and
Integration of Design.

The Recording Medium

Two types of tape are generally available, each having its own advantages and disadvantages. Paper-based tape has not been popular for professional use due mainly to surface finish. In order to get satisfactory signals from paper tape, pressure pads must be used to insure intimate contact of the oxide coating with the gaps of the magnetic transducers. This is considered a disadvantage on broadcast equipment due to increased head wear. In addition, the measured signal-to-noise ratios are slightly inferior when using paper-based tape. However, proper machine design can produce results from paper tape comparable to the average result now achieved with plastic tape on quality equipment.

Paper tape has one distinct advantage for accurate long-term timing. It is not seriously affected by tension or humidity in such a manner as appreciably to change its length. Where the values of noise obtained from paper tape are acceptable, the speed-control problem is much simplified. In those applications where plastic-based tape is required, one must consider the elasticity of the medium and the effects of heat and humidity coupled with tension. Such tape, when wound tightly in a moist atmosphere and then dried thoroughly, may become completely useless due to the stretching, warping, and multiple breakage which may occur while the tape remains in storage on the reel. These effects indicate the need for humidity control when close timing is desired. When the humidity is kept within a few per cent of a nominal, no appreciable errors should exist. Errors can exceed 5%, with a 20% to 30% differential in humidity. In addition, the elongation of tape due to tension is aggravated by humidity. It is generally acknowledged that plastic tape may be easily deformed beyond its elastic limits. A fact often overlooked, however, is that momentary deformation short of permanent strain may be one of the most troublesome factors in the control of average and instantaneous tape speed. For example, a tape which might be permanently deformed at 6-lb tension may stretch 1% or 2% momentarily with 3-lb tension and produce this percentage as "wow." This condition may also aggravate capstan control problems which will be described later. This factor is the proximate cause of most nonperiodic flutter in tape transport systems.

Tape tensions measured by ordinary means are *average* tensions. *Peak* condi-

tions may vary from this average by a factor of 4:1 or 5:1 on a well-designed machine under dynamic operating conditions. This condition, which we know to exist, creates the basic requirement of any tape drive: that the desired driving force must exceed the total friction in either direction by a factor of at least five, and preferably more. The corollary to this is that the maximum tension expected must never exceed that amount which will produce elongation when expressed directly as a percentage and designated "flutter." These forces may be caused by drag, take-up tension, edge-guide scraping, bearing friction, rubber creepage, vibration and other transient and periodic conditions. The minimum tape tension is a factor of minimum inertia levels and satisfactory tape winding for storage and handling.

Good practice would seem to indicate that the drag and take-up tensions should each equal a safe minimum for tape handling and the capstan drive should pull five times the maximum take-up tension. This procedure puts each tension at its minimum safe value. Particular care must be taken, of course, to prevent any uneven tensions, vibrations, or the rubbing of the edges of the tape on surfaces near the heads and capstan. If care is taken with the handling and storage of plastic tape and if machine tensions and design are reasonable, a satisfactory time-control condition may be obtained to a limit of less than 0.5 sec in 1200 ft of tape.

Capstan Drive

Capstan drive is used almost universally on magnetic tape recorders. This is due, in the main, to the ease of obtaining a constant single-surface speed (as in turntables) with the added advantage of greater energy storage due to higher speeds. Most recorders now available have capstans which, in themselves, can be manufactured to produce less than one tenth of one per cent "wow" or "flutter"; and which can, with synchronous motor drives, reproduce time to satisfactory tolerances for most purposes. At this point, however, most designs begin to experience difficulty. The problem is to couple the tape surface motion to the capstan surface in reference to a transducer spaced some distance from the point of capstan contact.

Two general methods have been used; i.e., the friction surface and the pressure roller. The friction surface suffers from the necessity that the tape tensions must remain constant and of a certain minimum dynamic value, or the tape will not be driven at a given instant. These tensions, when adequate, become sufficient to cause the various phenomena previously described and/or overdrive the capstan so as to cause slippage. The pressure-roller method is in more general use today. This method, however, suffers from certain pitfalls. The rubber surface, which is generally used, is under considerable pressure at the capstan against a small diameter. The surface speed of the rubber, therefore, changes sharply as it passes the capstan. If this rubber is substantially wider than the tape, the rubber surface will drive the tape and is driven by the capstan. Under this condition the creepage of the rubber under compression and motion influences the tape speed directly. As the diameter of the capstan and the durometer of the rubber are increased, this effect is decreased. At the same time, the driving friction between tape, capstan and rubber is materially decreased, increasing the likelihood of slippage. Under either extreme condition (and to a lesser extent between the extremes), the tensions from both the supply and take-up directions will influence the effect of creepage.

When the pressure roller is not wider than the tape, the tape is controlled by the capstan surface and the only slippage factor is relative to tensions and not to creepage. The requirements of tape guiding generally make this method difficult to achieve due to tendencies for

the tape to walk out of the capstan. Also, the increased friction of bearings under greater side-loading pressures may often become a serious factor. In general, the use of as hard a rubber as feasible against as large a capstan as possible with good antifriction bearings on both members will produce the most satisfactory results. These results are then limited by the control of tape tensions.

Tape Supply

The total system drag friction as viewed from the capstan must be as uniform as possible. Since the total must also be a fairly small quantity, the individual sources must be closely controlled. The loading effects of various amounts of tape on various sizes of reels must be minimized. The changes in tape path throughout a reel must not produce changes in tape-guiding friction. Particular care must be taken to insure that the edge guides do not function by brute force to control the tape path, since the pressure of the guides on the slit edges can greatly increase transient tensions and can buckle the tape away from the heads requiring excessive pressure-pad tensions. The dynamic effects of the motion of both tape and reels must be damped to prevent periodic variations in tape tensions. Above, all, the axioms of tape tension ratios must be observed.

Pressure Pads—Pro and Con

Two methods have been in general use to maintain coupling between the tape and the recording or reproducing heads. On professional machines using only plastic tape at high speeds, the combination of supply tension and of the elastic moment of inertia of the tape have generally been adequate to give satisfactory results. As tape speeds are decreased, this is not generally true. At 3.75 and 7.5 in/sec the required longitudinal tensions on the tape to provide adequate coupling exceeds the safe tensions on either paper or plastic tapes, if flutter is considered. On such machines the high-frequency response can be greatly improved by the addition of light pressure pads at the gaps. The only deterrent to this procedure is the increase of head wear and, to some extent, of maintenance. For most applications the improvement in performance is worth the inconvenience.

When paper tape is used, pressure pads become almost mandatory due to the surface irregularities of paper tape. A simple rule of thumb to consider when not using pressure pads is that the useful tension at the gap is equal to the system drag tension times the sine of the angle of incidence at which the tape approaches the head, less the tape stiffness over extremely short lengths.

Take-up Design

Take-up systems may be divided generally into two categories: the constant tape tension and the constant clutch-torque systems. Obviously, constant tape tension is more desirable from a theoretical point of view. On general-purpose recorders the choice is largely economic. If a common motor is used to supply power for a capstan and take-up, it is necessary to use a constant torque clutch in order to equalize the motor load and allow constant motor speed. This is because the power input to a clutch is the product of the speed of the driving member and the torque transmitted to the driven. If the tape tension is held constant, the driving torque required varies 4:1 on a 7-in. tape reel. If the torque is held constant, the tape tension will vary to the same degree.

On professional-quality recorders the goal becomes constant tape tension with means of supplying power from a separate source. The methods used have varied from gravity-operated clutches, in which the weight of the tape controls the tension, to the design of special torque motors whose stalled rotor and slow-speed torque curves are complementary to the changes in tape-reel diameters and weights.

An Integrated Design

If the most desirable features for tape transport and speed control are combined, the result might well resemble the following description.

The supply tension for the tape is provided by a gravity-operated clutch of very light weight and a felt damping pad ahead of the recording head, plus a light pressure pad at the head gap. The total of this tension is maintained at between 1 and 3 oz throughout the reel.

The take-up tension is supplied by a gravity-operated clutch pulling the tape directly from the capstan at from 1 to 3 oz of tension. A separate motor provides power for take-up, transmitting the power to the clutch at a speed not exceeding twice the maximum reel speed at the hub.

The capstan is large in diameter (perhaps over $1\frac{1}{2}$ in.). It is run on precision ball bearings with a ball thrust. The bearings are selected for both dimension and shock-excited noise. A synchronous motor drives the capstan through an idler or multiple-belt drive. The pressure roller is also large in diameter. It has a thick tire of hard synthetic rubber. It is approximately three times the width of the tape. The use of ball bearings is indicated here also. The path wraps the capstan at least 90° between the heads and the pressure roller. Tension on the pressure roller is to be adequate to create an average pulling power for the tape of between $1\frac{1}{2}$ and 2 lb. At this tension the rubber should not compress more than a few thousandths of an inch.

If such a design follows good engineering practice, it may be predicted that the long-term timing from the beginning to the end of a reel of tape will be maintained within less than a half-second time deviation from the nominal, without the use of special synchronizing means. Actually one such device with several tape channels produces repeated timing of all channels within approximately $\frac{1}{8}$ in. in 1200 ft on paper tape. This is equivalent to $\frac{1}{60}$ sec at 7.5 in./sec or an overall tolerance of nine millionths of one per cent. Tape measured on this machine by the elapsed-time method is now a standard of timing for one of the national networks to allow equipment comparison between stations.

When the flywheel or capstan itself is stable (neglecting tape coupling), the short-term flutter and wow should be dependably less than 0.15% rms, or 0.25% peak. As reference, it might be well to point out that this degree of stability is often obtained by manufacturers of competitively priced home recorders, up to the capstan surface. The poorer overall performance is generally traceable to the tape coupling and tension problems discussed above.

A recorder having these characteristics is suitable for most synchronous purposes where and when an absolute phase lock or absolute cue-in control is not necessary. In general, no difficulty should be experienced in using such tape for original preparation of movie sound tracks. With some of the editing procedures now in use, even plastic tape would be feasible. On paper tape, results could be better than one frame error in fifteen minutes. Admittedly, the pure mechanical approach to tape speed control is limited to applications where half-second tolerances are generally satisfactory. It is felt, however, that the investigation of basic principles has uncovered the possibility that many applications, hitherto seeming impractical, may be solved without the expense of synchronous tape equipment.

Acknowledgment

The author would like to express his appreciation for the cooperation and encouragement over an extended period of time of the following people and organizations: L. S. Toogood, L. S. Toogood Recording Co.; R. T. Van Niman; Minnesota Mining and Mfg. Company; and National Standard Co.

Discussion

Anon: The flutter at the capstan was of the order of 0.05%, as differentiated from the flutter at the head. I am wondering what measuring technique was used to determine the wow at the capstan?

Mr. Montgomery: Various means have been used, such as stroboscopic observation of check points on the surface of the flywheel, means of building up systems which have practically no tension or inertia and achieving low wow and flutter measurements to that degree, using capstan drives to pull the tape. Those measurements, by the way, were made on a peak-to-peak basis, when related to actual measurements using tape, rather than on an rms basis.

Dr. Kellogg: I remember a toy we played with in my youth, which consisted of a tin can and a string. You punched a hole in the bottom of the can, and threaded through it a piece of rather stiff string with a knot on the end, then rubbed the string with beeswax and rosin. When you pulled the string, you made a raucous noise, due to the intermittent grip of the fingers on the string. Perhaps a similar thing happens in tape machines, due to the friction of the tape on the magnetic head. Do you know of any indication that such a thing happens? It has been rather difficult to account for the amount of high-frequency flutter.

Mr. Montgomery: Any surface that the tape touches is bound to influence, to some degree, the driving friction of the tape. Since the tape is an elastic medium, if these tensions become at all appreciable, they are translated to the motion of the tape due to its elasticity. That has been a very serious problem with a great number of recorders and, for that reason, the manufacturers have tended to decrease the average running tensions of the tape. Pressure pads can produce exactly the same type of problem and for that reason the tensions and the materials used in the design of pressure pads have to be considered in the light of the longitudinal pressures that they exert when the tape is in motion.

Dr. Frayne: Concerning Dr. Kellogg's question, we have had opportunity over the past several years at Western Electric to measure flutter on a variety of tape machines. We find that most of them, when in good operating condition, have very good low-end flutter or wow. However, on a flutter-measuring set which is capable of measuring side bands up to 200 cycles, we often get rather abnormal values of flutter; in fact, as high as one quarter of one per cent. If you employ a flutter set capable of measuring side bands up to only 50 cycles, you omit the great bulk of the flutter frequencies.

Mr. Montgomery: I might add that some work I was engaged in a while back shows that there was another factor that is quite often indicated as flutter, and which perhaps is indistinguishable from it in the effect on motion analysis. The effect magnetically perhaps may be described as incremental-time (phase) products due to d-c electrical and magnetic components, such as microscopic discontinuities in tape coatings and bias-audio composites, as instantaneous values. To these must be added the side bands produced by *any* frequency modulation present. I don't know how to separate it from flutter in terms of measurement. I wish I did. It is that which we are prone to call modulation noise, which appears as side bands in that same range, quite often within a 200-cycle range of the fundamental and which produced, on most of your flutter-measuring devices, instantaneous changes in phase and in wavefront. Wavefront can confuse the flutter-measuring device so that you don't know which one you have.

Dr. Frayne: The effect on the ear, I think, is the same.

Television Studio Lighting Committee Report

By RICHARD BLOUNT, *Committee Chairman*

OVER A PERIOD OF YEARS the motion picture industry has developed lighting techniques which suit their modes of operation and, similarly, the techniques of the commercial still photographer have evolved to meet his requirements. It is not unreasonable therefore that the television industry, having borrowed some techniques from both groups, has gone on to develop additional methods to meet its peculiar needs.

In order to facilitate this development the Society has formed this Committee, composed of engineering personnel from various television stations, people engaged in motion picture activities, and representatives of the lighting industry. The Committee's members are:

H. R. Bell, Mole-Richardson Co.
A. H. Brolly, Television Associates
D. D. Cavelli, Signal Corps Photographic Center
H. M. Gurin, National Broadcasting Co.
H. A. Kliegl, Kliegl Bros. Universal Electric Stage Lighting Co., Inc.
Ted Lawrence, Columbia Broadcasting Co. (Alternate)
R. W. Morris, American Broadcasting Co.
R. S. O'Brien, Columbia Broadcasting Co.
Adrian TerLouw, Eastman Kodak Co.
M. Waring, Allen B. DuMont Laboratories
R. L. Zahour, Westinghouse Electric Corp.

In order to facilitate the investigation of lighting problems common to television stations, the membership has been divided into three groups. A Lighting Facilities Subcommittee including Mr. Brolly and Mr. Morris under the guidance of Mr. Kliegl are investigating:

1. The problems involved in rigging lighting equipment.
2. The power required.
3. The methods of controlling and distributing power throughout the studio.

In addition, this subcommittee plans to study the problems of electrical and lighting maintenance.

This group works closely with a second subcommittee, that on Lighting Techniques, which was until recently under the direction of Mr. O'Brien. Mr. Gurin has agreed to take on the chairmanship of this group because Mr. O'Brien is now spending most of his time in Los Angeles. Messrs. Lawrence and Cavelli complete the group. They are engaged in a study of current lighting practice as applied to theaters, where staging techniques are determined to a large extent by the physical arrangements, to studios where a circus may follow a dramatic show, and to small fixed areas such as daily newscasts, culinary exhibitions, and childrens' programs. While each area has some problems in common, each one must be handled separately if the maximum

Presented on May 3, 1951, at the Society's Convention in New York, by Richard Blount, General Electric Co., Nela Park, Cleveland 12, Ohio.

effect is to be obtained from the program. In addition this group has been asked to investigate special lighting effects that can be used to enhance the program. Some effects to be studied are background projection, the use of follow spots, and pseudo sunlighting.

A third very important group is engaged in the difficult activity of establishing a basic terminology. This group, including Messrs. Waring and TerLouw under Mr. Zahour's direction, has been very active in its efforts to establish names for various lighting techniques. This work is very necessary because even among the committee differences frequently arise over the meaning of various lighting terms. To date the committee has agreed to a division of lighting into three forms:

1. Base lighting,
2. Accent lighting, and
3. Effects lighting.

Tentatively "base light" has been defined as uniform illumination required on a scene to produce a television image having satisfactory resolution, tonal gradation and signal-to-noise ratio at the point of origin. "Accent lighting" has tentatively been defined as a directional illumination normally added to base lighting to improve the pictorial quality of the television image. No agreement has been reached on even a tentative definition of "effects lighting."

The subcommittee is also investigating technique of light measurement. Realizing that incident foot-candle measurements at times provide insufficient data, they are determining whether brightness measurements may also be used to advantage.

The committee has been meeting at three-month intervals. Our membership is at present predominantly from the East and perhaps should be broadened. Mr. Bell is our sole representative on the West Coast and considering the television activities there other people may wish to contribute to this group. Their participation will be welcomed.

Proposed American Standards

On the following pages appear three Proposed American Standards pertaining to magnetic recording. They cover the direction of film travel, type of base, speed, dimension and positions of magnetic sound tracks on 35-mm, 17½-mm, 16-mm and 8-mm motion picture films with standard perforations.

The proposals are the result of the work of the Sound Committee's Subcommittee on Magnetic Recording, under the chairmanship of G. L. Dimmick. The subcommittee has been active since October 1948, widely investigating the subject through meetings and correspondence among equipment manufacturers, studio sound departments and users of magnetic film.

The Sound Committee and the Standards Committee of the Society have approved preliminary publication of the proposals in the Journal for a ninety-day trial period. If, at the end of that time, no adverse criticism has been received, they will be processed as American Standards.

In the case of the proposals for 35-mm and 17½-mm film, one of the considerations affecting track location is the desirability of reproducing films of both widths on studio editing equipment in particular, and, consequently, the track location on 17½-mm film was made the same as the No. 1 track on 35-mm film, which is the track used when only one recording is made on 35-mm magnetic film. Careful cross-talk and scanning tests have shown the feasibility of recording three tracks on 35-mm film when it is desired to record dialogue, music and sound effects separately and simultaneously, for example, for selective later use and resulting economy of film.

The major equipment manufacturers are supplying equipment meeting these specifications which has proved satisfactory in motion picture studio operations. It should be noted that the 35-mm and 17½-mm proposed standards are for original recording and re-recording and do not apply to release film.

The 16-mm proposal applies only to film having both picture and sound. Later committee work will cover 16-mm sound film with full-width magnetic coating. It should be noted that the photographic emulsion for picture is in the standard position for 16-mm films, and the magnetic coating is on the base side along the unperforated edge. The point of sound translation is also specified as 26 frames which is the same distance and in the same direction from the corresponding picture as is the point of translation for photographic sound track. At least one projector manufacturer is presently considering manufacturing projectors to this proposed standard and others are expected soon.

The proposal for 8-mm film applies to film having both picture and sound. The magnetic coating is along the edge on the base side of the film outside the sprocket holes. The 24-frame speed is recommended for the more serious amateur and for use on professional sound films reduced from 35- or 16-mm material. The 18-frame speed has been selected to replace the former 16-frame standard because of the added improvement in sound quality and the somewhat smoother action in picture material. Several experimental projectors have been built to support the practicability of the proposed standard.

Subcommittee on Magnetic Recording
G. L. Dimmick, *Chairman*
Harold Bauman
H. N. Fairbanks
J. G. Frayne
Robert Herr
G. P. Mann
M. G. Townsley
D. R. White

Proposed American Standard

Dimensions for Magnetic Sound Tracks on 35-Mm and 17½-Mm Motion Picture Film

(First Draft)

PH22.86

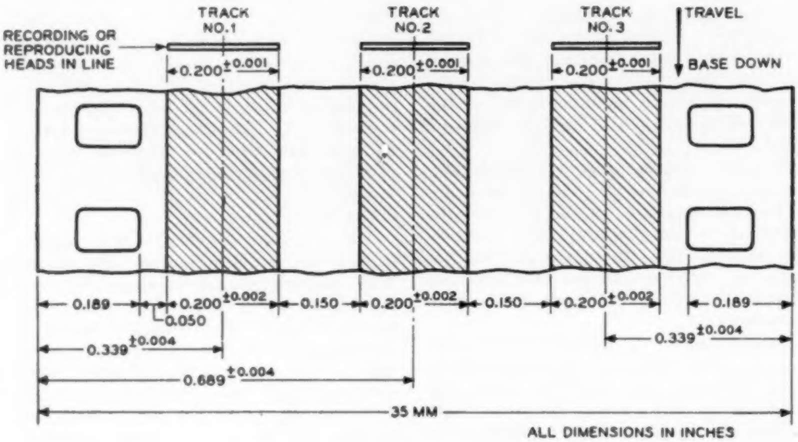
Note 1. This practice pertains to magnetic sound records, both single and multiple tracks, on 35-mm perforated film, and single tracks on 17½-mm perforated film.

Note 2. The film base shall be of the low-shrinkage safety type.

Note 3. With the direction of travel as shown in the drawing, the magnetic material is coated on the upper side of the film base.

Note 4. The magnetic coating is normally applied from edge to edge.

Note 5. Track dimensions and positions are given in inches. All dimensions are given relative to unshrunk film.



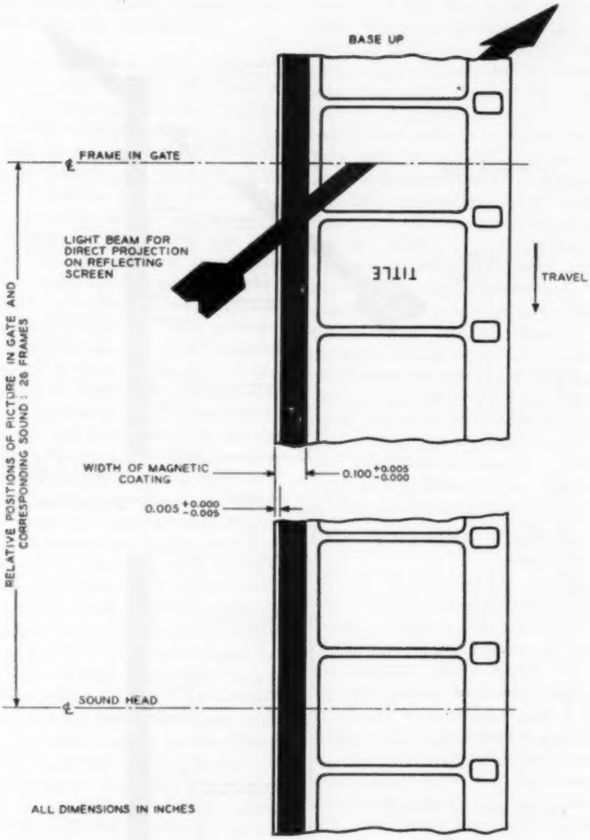
Note 6. Cutting and perforating dimensions and tolerances are identical to those given in Standard Z22.36, "Cutting and Perforating Dimensions for 35-Mm Motion Picture Positive Raw Stock."

Note 7. Track #1 is the preferred position for 35-mm single track recording, and is the standard position for 17½-mm recording.

Note 8. Recording and reproducing speed shall be 24 frames per second (Standard Z22.2). This is exactly 96 perforations per second and approximately 18 inches per second.

NOT APPROVED

Proposed American Standard **Dimensions for Magnetic Sound Track on 16-Mm Motion Picture Film**	PH22.87

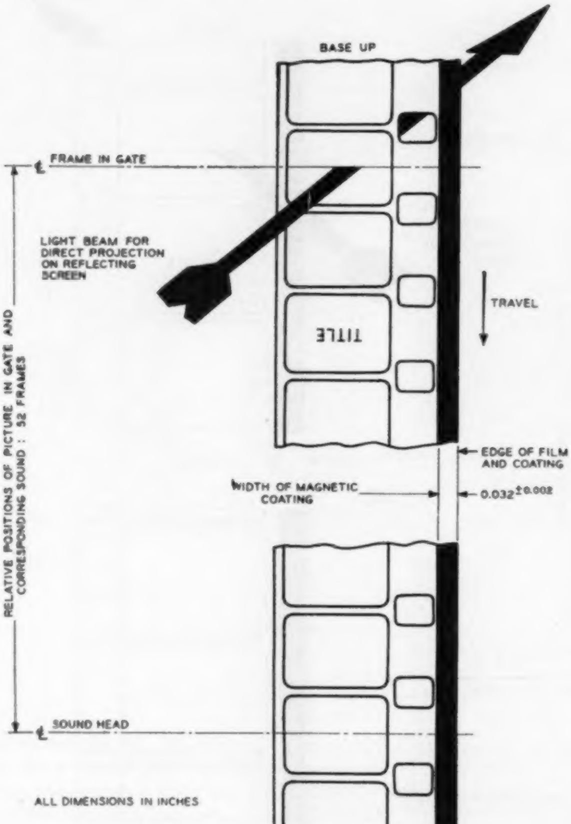


Note 1. The magnetic coating in the above drawing is on the side of the film toward the lamp on a projector arranged for direct projection on a reflection-type screen.

Note 2. Projection Speed — 24 frames per second.

NOT APPROVED

Proposed American Standard **Dimensions for Magnetic Sound Track on 8-Mm Motion Picture Film**	PH22.88



Note 1. The magnetic coating in the above drawing is on the side of the film toward the lamp on a projector arranged for direct projection on a reflection-type screen.

Note 2. Projection Speeds — 24 frames per second for professional use; 18 frames per second for amateur use.

NOT APPROVED

Board of Governors

The third meeting of the Board of Governors in 1951 was held in New York on July 19. Half-year reports were presented on the state of the Society's finances, on recent membership promotion activities, on publications and on the work of our engineering committees. Also, the Board approved the recommendations of the Nominating and the several award committees.

FINANCIAL The financial aspects of all Society operations over the first six months and the resulting cash position were reported upon by F. E. Cahill, Treasurer, who presented his own report, and, in the absence of R. B. Austrian, also presented the Financial Report.

With the exception of two membership activities, business operations for the first six months of 1951 were about even with the first half of the annual budget adopted in January and well ahead of last year. If the present trend continues, and presumably it will, this should be the best financial year in Society history. But the Board was in agreement that even though the monthly and quarterly operating statements show an attractive picture at the moment, the officers and Headquarters staff members responsible for budgets and financial plans should not relax their attention. They must not assume that "business as usual" represented by last year's or this year's financial reports is an automatic and perpetual condition. With the Society now 35 years old and in every respect healthy enough to continue for another long lap, it would be wise to base plans for the future on a period somewhat longer than just "next year."

A program of long range financing will be prepared for consideration by the Board at its October meeting. Along with the obvious provisions for sustained high level income over a period of several years, there should be plans for continued expansion of the work of engineering committees, the *Journal* and other services to the members and to the industries that employ them.

MEMBERSHIP Each year the Society gains new members but for some time the number of applicants accepted over a 12-month period has very nearly been offset by the number of current members who are delinquent in payment of their dues. Although the net figure, that is, the total of all members in all grades, has always been higher at the end than at the beginning of each calendar year, the growth rate from year to year has been disappointing. To partly remedy the situation the Board six months ago authorized employment of a full time Membership Secretary. Mrs. Beatrice Conlon of the staff began work in that capacity in March and a report of her efforts over the 4-month period was presented. Guests who had attended the 69th Convention were sent membership invitations and out of 25 replies received by July first, 16 applications were approved. Letters addressed to those current members who had not sent in their dues for 1951 produced a 10% return, or about 40 reinstatements. Other specific efforts accounted for a reasonable share of the 334 new members who joined before July 1. The Board called for increased effort on the part of all members of the Membership and Subscription Committee and urged that the major share of this effort be directed toward the up and coming young engineers who could derive real benefit from the *Journal* and other Society activities. They would also doubtless continue as members for a long time to come, if the Society is actually serving its fundamental purpose.

PUBLICATIONS Editorial Vice Presidents C. R. Keith and J. G. Frayne, the Editor Vic Allen, and Arthur Downes, Chairman of the Board of Editors, have devoted a great deal of effort to tightening the editorial policy of the *Journal*. They aimed at reducing delays between presentation and publication of technical articles, raising the average levels of both editorial and technical quality of papers submitted for the *Journal* so there would be a wider selection of suitable material from which to assemble any given issue and to increase the amount of information published. In addition, they wanted more pages in the "back of the book," this section that reports on the Society and its internal workings.

In a written report submitted by John Frayne, who was not able to attend, ample evidence of progress was presented. The change to two column format authorized last October had been made on schedule, beginning with the issue for January. New

paper and ink were also adopted. These changes were intended to give more words per page, improve appearance and readability, and at the same time permit somewhat greater flexibility in make-up of the "back of the book" and in articles with numerous illustrations. Twenty-five per cent more material was contained in the first six issues for 1951 than appeared in the first six last year and 60 per cent more than in the same period in 1947.

By working closely with the Mack Printing Company and by applying added personal effort, Vic Allen was able to make the *Journal* a larger, more professional magazine. In recent months, however, the addition of such items as the High-Speed Photography Bibliography, the 5-Year Index, the new style volume title page and index that appeared in June plus a series of technical papers that required more detailed care to publish, required so much extra attention that publication dates began to lag. Extra manpower seemed to be the only solution, so on Dr. Frayne's recommendation the Board authorized Vic Allen to employ an Assistant Editor, increasing the editorial staff to three.

The Papers Committee, for which the Editorial Vice-President is responsible, has been working seriously on plans for the 70th Convention. Fred Albin, Vice-Chairman, and Ed Seeley, Chairman, have switched the program into high gear.

Development of a high quality public address and discussion recording system for use at conventions had been assigned to Dr. Frayne. He appointed a committee under the chairmanship of Harry Braun to work out the detailed design. The Committee's recommendations were approved, so that work can be started at once.

ENGINEERING Fred T. Bowditch, Engineering Vice-President, reviewed the system of Stenotype recording and transcription used in the preparation of minutes of many of the engineering committees' meetings held during the 69th Convention. He criticized the use of "outside" help on this job because the results did not justify the expense. For that reason future meetings of engineering committees that Hank Kogel, Staff Engineer, cannot attend will be reported by a recording secretary, whom the chairman will appoint on the spot.

One of the methods of measuring lens transmission that the Optics Committee had considered suitable for a proposed standard is the subject of a U. S. Patent assigned to the Radio Corporation of America. Mr. Bowditch reported that since the patent could have been a serious obstacle to general use of the method it was fortunate that the Radio Corporation of America had seen fit to offer a paid up license to anyone interested for the sum of $10.00. Appreciation had been formally expressed in the June *Journal*.

Most important engineering item on the Agenda was concerned with the position which the Society would assume in connection with the forthcoming hearings on Theater Television of the Federal Communications Commission.

After duly considering the combined views of the Theater Television Committee and its Subcommittee on Distribution Facilities, under G. L. Beers and Pierre Mertz, Chairmen, the Board agreed that the Society should act on the recommendations and not make an appearance. Steps taken to notify FCC, industry trade groups that took part in this work and the press are reported upon elsewhere in this issue.

CONVENTIONS Although most members who help put on Society Conventions twice each year are concerned with only one at a time, Convention Vice-President Bill Kunzmann is always looking far into the future. Convention hotels are booking large conventions as far as two to three years ahead, so Bill has tied up these dates:

70th Convention, Hollywood Roosevelt, Hollywood, Calif., October 15–19, 1951

71st Convention, Hotel Drake, Chicago, Ill., April 21–25, 1952

72nd Convention, Hotel Statler, Washington, D.C., October 5–10, 1952

73rd Convention, Hotel Statler, Los Angeles, Calif., April 26–30, 1953

74th Convention, Hotel Statler, New York, October 4–9, 1953

The Board of Governors authorized these five reservations and learned that all Committees for the 70th Convention have been appointed and are now hard at work. Details are given elsewhere in this issue.

70th Semiannual Convention

Hollywood Roosevelt Hotel, Hollywood, Calif., October 15–19, 1951

You can bet that the 70th Convention will be up to Bill Kunzmann's usual standards. He has turned in two good ones every twelve months for 35 years and as Convention Vice-President and entrepreneur par excellence he should make the next the best so far.

During June, Bill met twice with President Peter Mole and the Pacific Coast Section Managers to arrange the feature events. He has prepared a list of these items in sequence and as soon as essential details are filled in by his planning team Bill will arrange for Vic Allen to print the advance notice and mail it to all members. The customary hotel reservation card will, of course, be included as will session titles and enough general information about the program to enable members to crystallize their personal plans.

Following the advance notice (by the shortest possible time interval) will be the tentative program, also to be printed by Vic Allen and mailed to all members. For each paper listed the tentative program will show title, author, author's affiliation, and a brief abstract of the paper's contents. Although some changes are inevitably made in the separate items and in their order of presentation after the tentative program is completed and before the final program goes to press, every effort is made to keep these changes to a minimum. The final program will be distributed at the Registration Desk on opening day, Monday, October 15.

PROGRAM *Fred Albin*, American Broadcasting Co., 4151 Prospect Ave., Hollywood, Calif.

As Papers Committee Vice-Chairman for the Hollywood area, Fred is in charge of organizing technical sessions, perhaps including a symposium or two. In making up the Program, he will be able to draw from fifty or sixty separate contributions offered directly by individuals or secured by other members of the Papers Committee. Help with procedure, and in the way of program suggestions, will come from J. G. Frayne, Editorial Vice-President, and E. S. Seeley, Chairman of the Papers Committee. When enough manuscripts have been received to give form to the program schedule, Fred will draft the tentative program. He urges that prospective authors who have not furnished either manuscript or author's form do so at once. Proper blanks are available from any of the Vice-Chairmen whose names are listed on p. 690 of the June *Journal*.

LUNCHEON AND BANQUET

Norwood Simmons, Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38, Calif.

An essential assignment in connection with the Monday luncheon and Wednesday banquet has been given to Norwood. He will schedule the presentation of all annual awards and help select the luncheon speaker. As Peter Mole's aide he will see that the "official" parts of both social events begin and end on time. He will also receive official guests, seat them, and serve as assistant host for each occasion.

LADIES *Mrs. C. R. Daily*, 113 N. Laurel Ave., Los Angeles 36.

As Chairman of the Ladies Committee Mrs. Daily will be official Convention Hostess. She will appoint the Ladies Committee, help with the program of entertainment for those of the fairer sex who attend, and while the Convention is in session she will be their guide and mentor.

MOTION PICTURES

Sid Solow, Consolidated Film Industries, 959 Seward St., Hollywood 38.

Motion Picture short subjects of better than average quality are used to open all technical sessions. Sid will schedule and book all the required films, arrange for delivery to the Hollywood Roosevelt before each session, and for pick-up afterward. In addition (as is customary) he will be superintendent of nonsense and engage the entertainer for the Monday luncheon.

PUBLICITY *Harold Desfor*, RCA Victor Div., Camden, N.J.

Taking a ten-day leave of absence from his regular job, Harold will set up publicity

headquarters just outside the Manager's office in the Hollywood Roosevelt Hotel. Beginning Monday he will prepare one or two daily press releases telling the story of the Convention as it unfolds. Before the doors open, however, he will have examined all manuscripts for newsworthiness and have prepared written abstracts (in layman's language) of the important parts of each paper. Reporters from trade and city papers can then study them all in understandable capsule form.

PRICES *Bill Kunzmann*, National Carbon Division, Box 6087, Cleveland 1, Ohio

Registration for the week	$ 5.00
Registration for a single day	1.00
Ladies Registration (week)	2.00
Luncheon (tax and tip included)	4.00
Banquet* (tax, tip and cocktails included)	11.00

** Bill Kunzmann said to remind everybody that the banquet is informal.*

Theater Television and the FCC

THE ENTIRE FIELD of theater television reached and passed an important milestone in the month of July 1951. After pleading the cause of theater television in many places and with great enthusiasm over the better part of a decade, the Society is no longer the only vocal public proponent. Theater circuits, exhibitors' trade organizations, manufacturers and the common carriers have joined the parade.

Equipment is being made, sold, installed and used on a commercial scale and the companies concerned with all aspects of equipment, operation and programming, as well as their trade organizations are beginning to move in a single general direction. Before long this link of communications between motion picture exhibition and television will be an integral part of the nation's entertainment industry.

As a consequence of this *imminent maturity*, our Theater Television Committee and its Subcommittee on Distribution Facilities believe that the new industry is well able to solve its own *commercial problems*. They have so advised the Board of Governors, recommending that the Society make no further appearance before the Federal Communications Commission in this connection, on its own initiative. Forthcoming hearings of the FCC described in Docket No. 9552 fall into the "commercial problems" category, because in addition to considering certain technical matters, the hearings will produce specific requests for allocation of sections of the radio frequency spectrum to the use of theater television. And they will also produce requests for the assignment of particular channels within those "theater television bands," to particular commercial interests. Using these two factors as a basis for its decision, the Board of Governors at its meeting in New York on July 19 ruled that the SMPTE would not appear at the forthcoming hearings.

FCC

Immediately following the Board Meeting, President Mole addressed the following letter to Mr. T. J. Slowie, Secretary of the Commission:

"The Society of Motion Picture and Television Engineers has given consideration to having its representatives appear at the hearings of the Federal Communications Commission beginning the first week in December and relating to channel assignments and related matters for theater television. The Society has for many years been active in studies of theater television methods, equipment and engineering aspects.

"Its primary functions in the developmental stages of theater television include the following: to coordinate the varied approaches which individuals and companies in the motion picture industry have taken toward the problems of creating the means of theater television; to establish desirable performance objectives practical of attainment at each stage of the art, and economic in the sense that equipment and facilities must be both manufacturable and operable; to arrange for the free exchange of information on video bandwidth, number of lines and suitable signal-to-noise ratios. These results have been accomplished through the Society's engineering committees.

"The consequence of this SMPTE coordination will doubtless be constructively evident in the statements soon to be filed with the Commission by commercial interests who propose to establish and to operate portions of a national theater television service. To further the development of such a service the Society is ready to serve the Commission as well as the motion picture industry through its study of particular technical questions.

"The Board of Governors of the Society believes that the Society's mission in the present preliminary stage of theater television development has been accomplished, citing as evidence the present broad interest of the industry as well as the constructive measures which the industry now proposes. Since the Society is a technical organization (and not a commercial institution), and since it will, of course, not propose to operate any portion of the theater television service, it does not propose to apply for the use of a band of frequencies in the radio spectrum, and for that reason does not propose to file an appearance nor otherwise participate in the forthcoming hearings. Further, the Society is convinced that the matters under consideration at these hearings can be adequately and informatively handled by the qualified engineering representatives of motion picture organizations there appearing.

"The Society has historically taken a constructive, cooperative and active position with respect to theater television. It is a pleasure to report that its Board of Governors continues its full interest in that field and has today authorized the following statement of its position with respect to the forthcoming hearings in the matter of Allocation of Frequencies and the Promulgation of Rules and Regulations for a theater television service.

1. The SMPTE, as a scientific and engineering society, is concerned primarily with technical matters. It is not concerned with commercial or industrial matters as such, and does not undertake to represent or speak for the motion picture industry or its parts.
2. The field of theater television has now reached a stage of technical and commercial development such that individual organizations appear qualified to express their viewpoints. Accordingly, the participation of the SMPTE in regulatory hearings no longer appears necessary.
3. However, upon the request of the FCC the SMPTE will assign to its technical committees the task of studying specific technical questions and will thereafter present to the Commission the technical opinions and data they can produce.

"The Society particularly directs the attention of the Commission to its willing offer of further technical service whenever requested."

Industry

Since other industry groups had of recent years been either taking an active part in the Society's committee deliberations or following closely, developments within its committees, it was particularly important that they know where the Society stands at the present time. To keep them informed, President Mole wrote on the morning of July 20 to the Presidents or senior staff members of these eight organizations:

Motion Picture Association
Theatre Owners of America
Society of Independent Motion Picture Producers
Allied States Association of Motion Picture Exhibitors
Motion Picture Research Council
Metropolitan Motion Picture Theatre Owners Association
Independent Theatre Owners Association
National Exhibitors Theater Television Committee

Enclosing a copy of the statement to the FCC, the letters read in part:

"We believe the cooperative spirit that has characterized the industry-wide interest in theater television over the last few years has formed a firm basis for an effective theater television service, and we earnestly hope it will continue. The present outlook is most encouraging.

"In the same constructive spirit I have been asked by our Theater Television Committee and its Subcommittee on Distribution Facilities to extend the following invitation to all industry groups who have taken part in our work or otherwise shown a serious interest. If you find it convenient please pass this invitation along to the members of the [your organization] as

evidence that the SMPTE has no intention of stepping aside at this juncture.

"[Your organization] is invited to call upon the Society of Motion Picture and Television Engineers at any time for assistance in the study of specific technical matters. The results of such studies would, as is customary, be presented for free use of the industry at large."

Continued Interest

Mr. Mole and the Board felt it was important to avoid giving the impression that the Society was stepping aside now, after so many years of active interest in promoting early technical progress in this comparatively new field. The present move implies rather that the Theater Television Committee is now ready to concentrate on technical details and, like all other engineering committees within the Society, is at the service of all segments of the industry.

For a review of past work in this connection, look up the following:

1. "Statement on theater television," Theater Television Committee, D. E. Hyndman, Chairman, *Jour. SMPE*, vol. 53, pp. 354–362, Oct. 1949.
2. "FCC allocation of frequencies for theater television," *Jour. SMPE*, vol. 53, pp. 351–353, Oct. 1949.
3. "Theater television," Theater Television Committee, D. E. Hyndman, Chairman, *Jour. SMPE*, vol. 52, pp. 243–272, Mar. 1949.
4. "Statement of SMPE on revised frequency allocations," Paul J. Larsen, *Jour. SMPE*, vol. 48, pp. 183–202, Mar. 1947.
5. "Report of the Committee on Television Projection Practice," P. J. Larsen, Chairman, *Jour. SMPE*, vol. 47, pp. 118–119, July 1946.
6. "Frequency allocations for theater television," *Jour. SMPE*, vol. 45, pp. 16–19, July 1945.
7. "Statements of the Society of Motion Picture Engineers on allocation of frequencies in the radio spectrum for theater television service as presented before the Federal Communications Commission," *Jour. SMPE*, vol. 44, Feb. and April. 1945.

Letters to the Editor

Re: A Study of Current Misconceptions in the Optical Theory of Rotating Prisms for High-Speed Cameras

Summary: The analysis of the rotating prism, as published by J. H. Waddell in this JOURNAL, *is wholly invalidated by an initial mathematical error. The correct calculation shows increasing speed of image displacement for increasing angle of rotation—a result directly opposite to that obtained by Waddell. Moreover, the advertised statement that "high index low dispersion glass" improves the resolution is without real foundation, as the influence of the value of the refractive index on the prismatic aberrations is practically insignificant.*

A DESCRIPTION of the image formation by rotating prisms was given by J. H. Waddell,[1] with particular attention to the change in the speed of image displacement with increasing angle of rotation.

Unfortunately, a substantial mathematical error crept into the basic formula upon which Waddell's investigation was built up. His formula (5), which should be the differential quotient of equation (4), is essentially incorrect. The mistake in differentiation led to the conspicuously false Fig. 2 in Waddell's paper, showing a curve turning downward to zero speed for increasing angle. In reality, the correct curve turns upward with increasing angle.

The writer has previously given a quantitative survey of the optical aberrations in question.[2] The image produced by the camera lens is continuously displaced by the rotating prism during the exposure. The displacement is

$$D\frac{n-1}{n}\left[x+\left(\frac{n+1}{2n^2}-\frac{1}{6}\right)x^3\right] \quad (1)$$

in which D is the thickness of the polygonal prism, n is the refractive index, and x is the angle of rotation in radians (i.e., the angle between the optical axis and the normal to the prism face).

The angle x being proportional to the time, the speed of the image displacement is proportional to the differential quotient of formula (1):

$$D\frac{n-1}{n}\left[1+3\left(\frac{n+1}{2n^2}-\frac{1}{6}\right)x^2\right] \quad (2)$$

This shows a fast increase of the image displacement for greater values of the angle x. Against this result, Waddell's Fig. 2 shows a decrease to zero and even to negative speeds with increasing angle, which is obviously wrong.

In Waddell's paper, as well as in other descriptions, particular emphasis is laid on the statement that improved resolution has been achieved by a new prism made of "high index low dispersion glass." However, this cannot be motivated by the slight influence of the refractive index on the nonlinear term in formula (1), as the whole effect of this aberration is practically obliterated by a suitably chosen value for the thickness D of the prism, which fact should be carefully realized. The value of the thickness D is usually chosen so that formula (1) indicates complete image coincidence for three positions of the rotating prism, representing, the beginning, the middle and the end of the exposure time. Thus any possible effect of nonlinearity is deliberately restricted to some intermediate positions of the prism, which means such small numerical values for the residual nonlinearity, that this aberration is practically eliminated, irrespectively of the value of the refractive index. It would be rather meaningless to argue that the coefficient of x^3 in formula (1) has the value $\frac{7}{18}$ for $n = 1.5$, and the smaller value $\frac{5}{24}$ for $n = 2.0$, since the practical effect on the image formation in either case is negligible, if the exact value for the thickness of the prism has been properly chosen.

As far as dispersion is concerned, its effect is proportional to the angle of rotation during the actual exposure in the high-speed camera, but it remains negligible for any rotating prism of low dispersion glass. Thus it remains to find out how other rotational aberrations depend upon the refractive index. In this respect, only prismatic coma and astigmatism have to be considered. The numerical value of these aberrations is proportional to $\frac{n+1}{n^2}$, if n is again the refractive index of the prism. Consequently, under otherwise identical conditions, a polygonal prism of high index glass (e.g. $n = 1.8$) would reduce prismatic coma and astigmatism by only 20%, as compared with the case of a prism of low index glass, such as $n = 1.5$. The practical insignificance of such a slight change in the size of aberrations can be illustrated as follows: Let us consider a camera with a rotating prism of high index glass ($n = 1.8$), under the condition of an overall limitation of the angle of incidence to $7\frac{1}{2}°$. Replacing this high index prism by a low index ($n = 1.5$) prism of suitable thickness, the optical aberrations remain exactly the same if the maximum angles of incidence are limited to 7°, i.e., only half a degree below the limits referred to in the allegedly ideal case of a high index glass.

This comparison shows that there is no real meaning in the argument of the "high index low dispersion glass," however esoteric an appeal might emanate from it.

The problem of optical improvement of this type of high-speed cameras is neither so simple nor so limited and hopeless, as suggested by recent literature. As soon as priority is granted to the optical problem, an unexpected progress in the construction of high-speed cameras of the rotating prism type will become possible. The presently prevailing attitude is based on the principle of a preconceived gear-box, which is really a Procrustean bed into which the optics has to be stretched or mutilated. There are surely more drawbacks than advantages in having a gearing between film driving and prism movement. But such a gearing is not an inherent feature of the construction, as the optical solution is compatible with a single rotating unit, serving the double purpose of optically displacing the image and mechanically displacing the film.

March 24, 1951

J. Kudar
601 W. 113th St.
(Apt. 10F)
New York 25, N.Y.

References

1. J. H. Waddell, "Design of rotating prisms for high-speed cameras," *Jour. SMPE*, vol. 53, pp. 496-501, Nov. 1949.
2. J. Kudar, "Optical problems of the image formation in high-speed motion picture cameras," *Jour. SMPE*, vol. 47, pp. 400-403, Nov. 1946.

Errata

J. H. Waddell, "Design of rotating prisms for high-speed cameras, *Jour. SMPE*, vol. 53, pp. 496–501, Nov. 1949.

Page 497: *For*

$$\frac{d(ss')}{dt} = kT\left[\frac{\cos i - 4(n^2 - \sin^2 i)\cos 2i - \sin^2 2i}{4(n^2 - \sin^2 i)}\right] \tag{5}$$

read

$$\frac{d(ss')}{dt} = kT\left[\cos i - \frac{4(n^2 - \sin^2 i)\cos 2i - \sin^2 2i}{4(n^2 - \sin^2 i)}\right]. \tag{5}$$

Page 498: *For* Fig. 2, *substitute* the figure shown on p. 83.

Reply to the Letter Above

In reviewing the Letter to the Editor by Mr. Kudar, in reference to a study of current misconceptions in the optical theory of rotating prisms for high-speed cameras, there are a number of very interesting observations to be made in reference to this critique by Mr. Kudar.

There was, as has been turned over to the Society, a typographical error in Formula 5 in the paper, *Design of Rotating Prisms for High Speed Cameras* by John H. Waddell, and consequently in the calculations that illustrated Fig. 2 positive values are shown rather than negative values as the relative velocity. However, quoting from a letter from one of my former associates, it is to be pointed out that this does not affect the validity of thinking in the design of rotating prisms in the least.

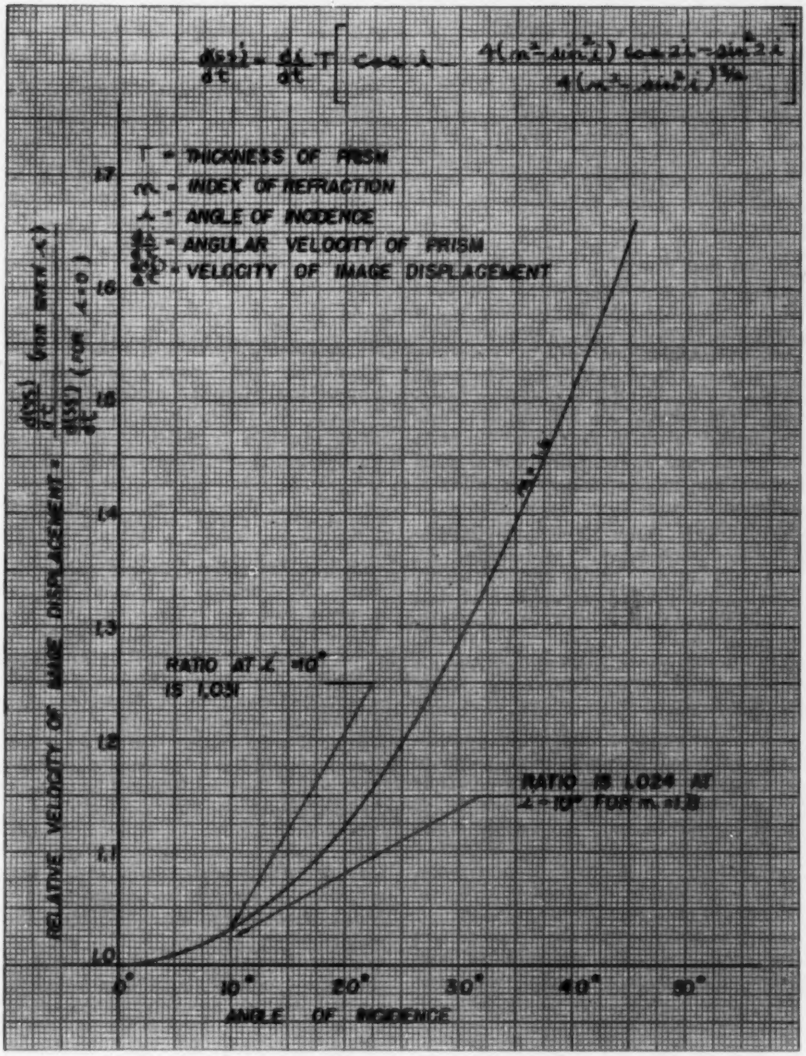
As one recalls from the oral presentation of this paper in the city of Washington at the first High-Speed Photography Symposium, the data to indicate that the high index glass prisms would prove of advantage was illustrated with a number of curves covering the various types of prismatic aberrations and distortions from the Kudar paper which was published in the *Journal* (vol. 47, pp. 400–403, Nov. 1946). In those figures it can be shown conclusively, as was demonstrated, that the optical quality of the image is improved by going to the higher index glass. Furthermore with the new Kodak high index low dispersion glass many improvements have been made practically in the formation of the optical image transmitted through the prism and on to the film plane both by the use of this glass and reducing the angle of incidence through which the exposure was made.

Practical considerations in the design of high-speed cameras indicate that the engineers are more interested in a very short cycle of exposure than such as would be required for continuous projection.

There is considerable stress placed by Mr. Kudar in the selection of the high index glass versus the low index glass. It must be remembered that radius in centrifugal force is reduced through the use of high index glass and any factor which can be made to reduce centrifugal force in very high speed moving mechanisms is to be considered seriously. It is not felt that the approach has been esoteric as Mr. Kudar has emphasized but primarily from a practical design wherein the practical optics do not necessarily meet with the approval of the theoretical man. There has to be a compromise between theory and practice at all times and when one is able to design a camera which produces a picture which is as steady as one taken with an intermittent camera and with resolving power equal to that of the normally fast films of today the compromise in the practical optics has been well satisfied.

As far as the comment about gear trains et cetera, they do not enter into the picture in the least because the tolerances to which cameras are made now are primarily proprietary information and therefore it is not felt that it is wise to discuss tolerances of manufacture of high-speed motion picture cameras in a paper of this type.

It is felt that if one examines pictures taken with the rotating prism cameras of today that they will be very satisfied with the photographic quality obtained. True, the next problems of design, of course, are to produce sprockets and other parts of the moving mechanism which are more ideally suited for both super speed operation wherein the cameras will operate at



four times their present rate of speed or larger image size such as could be obtained on a full frame 35-mm camera both of which are under current development.

June 20, 1951

John H. Waddell
850 Hudson Avenue
Rochester 21, N.Y.

[At press time, a Letter from Dr. Kudar came to the Editor further setting forth Dr. Kudar's ideas on the problem of centrifugal stress and strain in rotating prisms.]

Engineering Activities

ASA Standards for Color

American Standard Methods of Measuring and Specifying Color, Z58.7.1-3, 1951, approved April 13, 1951, have been published by the American Standards Association. They consist of three parts, each one numbered differently so that workers concerned with separate phases may refer to each part separately. This Z58.7 set of standards is a revision of War Standard Z44-1942, taken over for revision by the recently formed ASA committee Z58, Sectional Committee on Standardization of Optics, Francis W. Sears, Chairman, sponsored by the Optical Society of America. The revision was handled by a subcommittee of which David L. MacAdam of the Eastman Kodak Co. served as chairman. The three standards are titled as follows:

Z58.7.1-1951, American Standard Method of Spectrophotometric Measurement for Color;

Z58.7.2-1951, American Standard Method for Determination of Color Specifications;

Z58.7.3-1951, American Standard Alternative Methods for Expressing Color Specifications.

The first standard states the scope, then sets up seven provisions that relate to spectrophotometric measurement of color: 1, wavelength range; 2, bandwidth; 3, stray radiant energy; 4, nominal wavelength; 5, photometric scale; 6, spectral reflectance; 7, spectral transmittance. This is followed by a discussion, with nine numbered paragraphs.

The second standard sets up procedures for computing color specifications from spectrophotometric measurements in terms of the well-known and widely used tristimulus values X, Y and Z which are based on values for the equal-energy spectrum (and the "Standard Observer") adopted in 1931 by the International Commission on Illumination (380-780 mμ). Tables of values I.C.I. Standard Source C (380-770 mμ) are included for use both by the weighted ordinate (10-mμ interval) method and the selected ordinate method of calculation. Trichromatic coordinates (x, y, z) are given for the spectrum (380 to 780 mμ in 5-mμ intervals). The usual ICI (x,y)-chromaticity diagram is presented as the American Standard Chromaticity Diagram. All illuminations other than ICI Standard Source C are referred to as "nonstandard," and while it is pointed out that sometimes it may be important to use other sources in computation, the result "should not, however, be designated American Standard."

The third standard establishes alternative methods for expressing color in terms of dominant wavelength, purity and luminance; and secondly, in terms of Munsell hue, Munsell chroma and Munsell "value," "by interpolation in tables and charts prepared by the Subcommittee on the Spacing of the Munsell Colors of the Colorimetry Committee of the Optical Society of America, 1943." It is noted that these two sets of terms specify quantities that correlate more or less satisfactorily with hue, saturation (chroma) and lightness (value), defined as "features of color sensation and perception," but that the Munsell terms correlate somewhat better than dominant wavelength, purity and luminance for opaque, reflecting materials under usual conditions of observation.

There are many things in these standards that need to be studied. In some respects they are wordy and less clear than Z44-1942 which they are intended to replace. In other respects they are an improvement. The limitation they set, * that to comply with American Standard Methods one must do all colorimetric measurement and specification through spectrophotometry, is so extreme and so impracticable, in the opinion of the reviewer, that it will certainly lead to revisions in the standards if they are to become as useful in American practice as they could be. Omission of

* The standards set this limitation, although the Foreword states that any method may be used for sections 1 and 2 that will provide equivalent results. Specific note is made, however, that "This Foreword is not a part of the American Standard Methods. . . ." Either the note is incorrect, so that the Foreword should be a part of the standard, or only specifications arrived at through spectrophotometry comply with the standard methods.

direct and full reference to the internationally adopted resolutions of the 1931 (and other) meetings of the International Commission on Illumination, as the basis for these American Standards, is an omission that is confusing. American acceptance of so much of the ICI recommendations for colorimetric practice is so very general that it would have clarified the meaning of some of the American Standards provisions if more direct reference were made as to those parts adopted, and those parts omitted, of the ICI recommendations. (A typographical error in the heading of the last section of the third standard should be noted: "Deflecting" is written for Reflecting.)

However, the committee has worked long and hard to reach a point of agreement and of ASA approval and publication. Dr. MacAdam served as chairman of the subcommittee, and he had on the committee many members who served as representatives of ASA member-associations, firms, or cooperating governmental organizations. Among them were: Carl Z. Draves (for the AATCC); I. H. Godlove (for the Ansco division of General Aniline and Film Corp.); S. M. Newhall (for APA); M. Rea Paul (for ASTM); A. J. Werner (alternate for Corning Glass Works); Wm. F. Little (for Electrical Testing Laboratories); Norman F. Barnes (alt. for General Electric Co.); C. L. Crouch (alt. for IES); W. R. Brode (for OSA); Fred E. Altman (for SMPTE); D. B. Judd (for National Bureau of Standards); and E. K. Kaprilian (for Dept. of Army Signal Corps). (Initials have been used for ISCC member-bodies.)

Later it may be useful to publish a critical review of these standards, but at present it seems enough to let all color workers know that we now have available a set of ASA standards for use in measuring and specifying color. Copies of the set of three standards (15 pp.) may be purchased at fifty cents per set direct from the American Standards Association, 70 E. 45th St., New York 17.—D.N. (*Reprinted from I-SCC News Letter No.* 94)

Back Issues of the Journal Available

Three and one-half years of the Journal, July 1947 through December 1950, are available at the job lot price of $25.00 from Mr. Max Prilik, c/o Circle Theater, 82 H Grant Circle, The Bronx 60, N.Y.

SMPTE Officers and Committees: The roster of Society Officers and the Committee Chairmen and Members were Published in the April *Journal*.

Obituary

Albert L. Raven died on July 11 after a long illness at the age of 75. He was President of the Raven Screen Corp., 124 E. 124th St., New York, which he founded in 1921.

As a young man he had traveled on cruise ships as a photographer for Underwood & Underwood. He also had been employed by the Nicholas Power Co., working with motion picture equipment, before developing and marketing his ideas for motion picture screens. He invented a perforated screen and perfected a "halftone" screen with high reflective powers accomplished with a facing of cotton backed by titanium and rubber to get white color and opaqueness. This screen was used by Eastman Kodak Co. for its *Cavalcade of Color* at the New York World's Fair. In the 1930's the Raven Screen Co. boasted "a screen in every house on Broadway." More recently the company has concentrated on screens and related equipment for homes and institutions. Mr. Raven had been a member of this Society since 1924.

New Members

The following members have been added to the Society's rolls since those published last month. The designations of grades are the same as those used in the 1950 MEMBERSHIP DIRECTORY.

Honorary (**H**) Fellow (**F**) Active (**M**) Associate (**A**) Student (**S**)

Aerts, Rene, General Sales Manager, The Gevaert Co. of America, Inc., 423 W. 55 St., New York 19, N.Y. (**A**)

Applebaum, Joseph H., Cameraman, Coronet–Industrial Newsreels, Inc. **Mail:** 9 Post Ave., New York 34, N.Y. (**M**)

Bassett, Fred E., Jr., Motion Picture, Sound and Projection Engineer, RCA Service Co., Inc. **Mail:** 1131 Venetia Ave., Coral Gables, Fla. (**M**)

Boyers, John S., Engineer, Magnecord, Inc., 225 W. Ohio St., Chicago 10, Ill. (**A**)

Brown, Freeman H., Director, Photo Laboratory, The University of Wisconsin. **Mail:** 1204 West Johnson St., Madison 6, Wis. (**A**)

Clemson, Stanley L., Sound Engineer, Queensway Studios. **Mail:** Valley Farm Rd., Pickering, Ontario, Canada. (**M**)

Cummings, Wilbur H., Radio and Television Broadcasting, American Broadcasting Co. **Mail:** 427 Cottage Ave., Glen Ellyn, Ill. (**M**)

Downs, Charles W., Jr., Free-lance Assistant Cameraman. **Mail:** 1060 Hunter Ave., Pelham Manor, New York. (**A**)

Dunkelman, Gerald F., Sound Engineer, RCA Service Co., Inc. **Mail:** 194 Oakdale St., Staten Island 12, N.Y. (**A**)

Frank, Emil H., Television Executive. **Mail:** 550 Fifth Ave., New York, N.Y. (**A**)

Harding, H. Theodore, Motion Picture Product Manager, E. I. du Pont de Nemours & Co., Inc., 1450 Nemours Bldg., Wilmington, Del. (**M**)

Indjian, Daniel, University of Southern California. **Mail:** 1470 S. Shenandoah St., Los Angeles 35, Calif. (**S**)

Irvine, William L., Photographer, Corps of Engineers, U.S. Army. **Mail:** 2919 South 8th St., Kansas City 3, Kan. (**M**)

Kaplan, Richard, Dept. of Cinema, University of Southern California, Los Angeles 7, Calif. (**S**)

Koppel, Leo, Works Director, Ship Carbon Co. of Great Britain, Ltd. **Mail:** 51 Mount Pleasant Rd., Chigwell, Essex, England. (**A**)

Lummis, Oscar W., Sound Engineer, RCA Service Co. **Mail:** 3009 Magee Avenue, Philadelphia 24, Pa. (**A**)

Mahon, John C., Jr., Instructor, Motion Picture Photography, University of California at Los Angeles. **Mail:** 6608 Jamieson Ave., Reseda, Calif. (**A**)

Marcus, Joseph, Engineer, Federal Manufacturing and Engineering Corp. **Mail:** 1269 E. 89 St., Brooklyn 36, N.Y. (**M**)

Mathiesen, George H., Television Engineer, KPIX, Inc. **Mail:** 301 Ricardo Rd., Mill Valley, Calif. (**A**)

Meyer, H. J., Factory Representative, West Coast, Wollensak Optical Co. **Mail:** 1260 Lago Vista Dr., Beverly Hills, Calif. (**M**)

Pedersen, Raymond L., University of Hollywood. **Mail:** 930 N. Edgemont St., Los Angeles, Calif. (**S**)

Polito, Eugene E., Free-lance Cinematographer. **Mail:** 1456 N. Ogden Dr., Hollywood 46, Calif. (**M**)

Rella, Fred A., Motion Picture Production Supervisor, New York State Dept. of Commerce, Motion Picture Unit, 40 Howard St., Albany, N.Y. (**M**)

Rogan, Barney B., Electrical Technician & Sound Recordist, Mode-Art Pictures, Inc. **Mail:** R.D. #12, Pittsburgh 29, Pa. (**A**)

Schick, Elliot, Producer-Director, TV Films, President, Nova Productions, Inc. **Mail:** 179 West St., New York 7, N.Y. (**A**)

Sheldon, Irwin R., Design Engineer, Precision Laboratories. **Mail:** 300 Ocean Parkway, Brooklyn 18, N.Y. (**A**)

Waner, John M., Motion Picture Film Dept., West Coast Div., Eastman Kodak Co. **Mail:** 4112 Arch Dr., North Hollywood, Calif. (**A**)

Welty, Thomas D., Assistant Construction & Operating Engineer, School of Music, Motion Picture and Broadcasting Studios, University of Washington. **Mail:** 12047 14th Ave., N.E., Seattle 55, Wash. (**A**)

Wolff, Alfred, Cinematographer, Lecturer. **Mail:** 3426 Elaine Place, Chicago, Ill. (**A**)

CHANGE OF GRADE

Gavey, Thomas W., Captain, U.S. Air Force. **Mail:** P.O. Box 2610, Washington, D.C. (**A**) to (**M**)

Chemical Corner

Edited by Irving M. Ewig for the Society's Laboratory Practice Committee. Suggestions should be sent to Society headquarters marked for the attention of Mr. Ewig.

New Uses of Glycerine An article by M. A. Lesser in the October 1949 issue of *Commercial Photography* describes some interesting uses of glycerine for removing negative scratches and as a wetting agent in developers for aiding the elimination of streaks.

Non-Skid Floor Wax "Cetox" is a high-gloss floor wax which is slip proof whether it is wet or dry because it's "hydraoxated." This product has the UL label and is manufactured by Chemical Service of Baltimore, Howard and West Streets, Baltimore 30, Md.

Fireproofing "Ruflan" is a flame retardent spray of plastic made by E. I. DuPont.

To Keep Chemicals Dry and Uncontaminated A convenient drum cover made of paper containing Neoprene. This is superior to wooden barrel heads and fiber covers or even metal drum lids for keeping chemicals in containers dry and in an uncontaminated condition. They are very easy to get on and off. The vendors are the Chase Bag Co., 1500 South Delaware Avenue, Philadelphia, Pa.

Disinfectant Soaps The Davies Young Soap Company, Dayton, Ohio, makes a concentrated soap with a high germicidal effect, "Germelin," which should be excellent for washing developing and water tanks and would go a long way toward the elimination of that Monday morning smell.

Prevention of Slime in Wash Tanks "Algex" is a phenolic derivative sold by the L. B. Russell Chemicals, Inc., of 60 Orange Street, Bloomfield, N.J. It is a good destroyer of slime and algae growths found frequently in wash tanks. It comes in convenient tablets which can be dropped in the bottom of the tank near the water inlet.

Stable Color Developer "Genochrome" is a derivative of p-aminodiethylaniline which has greater resistance to aerial oxidation and is less toxic than most color developers. The article describing this appears in *The Royal Photographic Society Color Group Bulletin*, No. 13. It is written by G. T. J. Field and D. H. O. John.

Conservation of Water Washing of film serves a dual purpose. The first is to remove soluble silver salts because, if allowed to remain, these cause staining and discoloration. The removal of silver salts is best insured by a two-bath system of fixation. The second function of washing is the removal of hypo. If allowed to remain in excessive concentrations will result in fading and discoloration.

The reduction of the hardening properties of the fixer, maintaining the wash water at as high a temperature as possible, adequate agitation, frequent changes of washing, avoiding contamination of each wash section by the use of squeegees, all aid in the reduction of the quantity of water required for washing. A complete story of this may be found in the article by J. I. Crabtree, "How to Save Water," appearing in *The Photographic Science and Technique Journal*, Section B, August 1950, pages 70–74.

Flow Meter The Builders-Providence Company, 419 Harris Ave., Providence 1, R.I., has designed a compact, easily installed, self-contained and self-operated flow meter, "Propeloflo." The flow through main or auxiliary pipelines is all that is needed to run this meter—no mercury, pressure piping, or electrical connections are required.

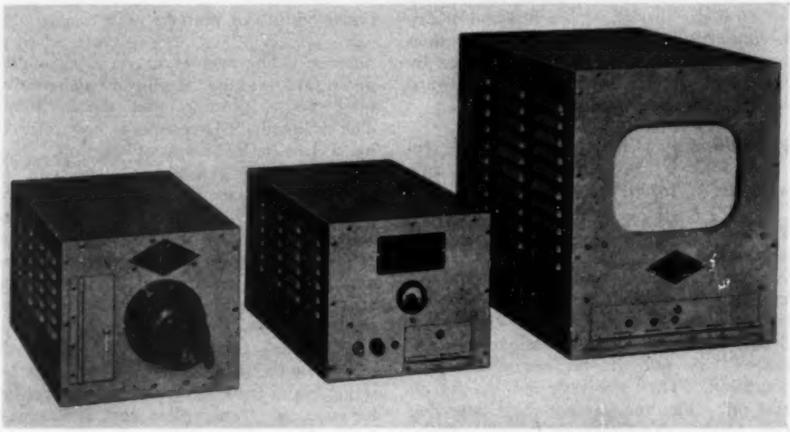
Make Your Own Distilled Water "Filtr-Ion" is a new and refillable ion-exchanger unit for small quantity uses which delivers water equal to triple distilled water. It is manufactured by LaMotte Chemical Products Co., Baltimore 4, Md.

This May Solve Your Dust Problem An easily applied, stainless "dust sealer" made by the West Disinfecting Co., 46-16 West St., Long Island City, N.Y., reduces dust to a minimum by leaving an antiseptic film to which dust adheres. This film is then easily removed. One gallon covers 4,000 sq ft.

A New Adhesive Tape This product is called #666 and is made by The Minnesota Mining Company. It is cellophane tape coated on both sides with adhesive for which many uses may be found in the laboratory. It does not fog or desensitize photographic material.

New Products

Further information about these items can be obtained from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of news items does not constitute an endorsement.



The Utiliscope is a closed-circuit television system developed by Diamond Power Specialty Corp., Lancaster, Pa. Simplicity in circuits and controls is a basic feature of this industrial instrument. The receiver is a Farnsworth cold cathode, image-dissector, camera tube. The complete system of camera, power supply and monitor as shown in the illustration is designed for portability and weighs 110 lb. The power supply can be placed as far as 25 ft from the camera and the monitor can be up to 1000 ft away. The lens used as standard equipment is 90-mm, $f/1.4$, coated, focused by rack-and-pinion gear. A remote focusing drive can be incorporated, however.

Only 17 tubes, including the camera tube, are employed. A 10-in. picture tube is standard but 12- or 16-in. tubes can be substituted. The system has a 300-line resolution.

A trial use of the Utiliscope in a Hollywood motion picture studio is reported by W. W. Herlihy, Sales Service Engineer for the Diamond Power Specialty Corp. The possible effectiveness of a particular movie set for a forthcoming circus production was tested with the Utiliscope camera and power supply suspended on a small trapeze opposite the performers' trapeze in preference to building a scaffold to support a studio camera and two cameramen. A mannequin was used as the stand-in and the motion picture of the swinging trapeze was transmitted from the swinging camera to the receiving unit on the floor. After this inexpensive preview the director decided to abandon the scene, having incurred very little expense for the rejected shot.

Society of Motion Picture and Television Engineers

40 West 40th Street, New York 18, N.Y. Tel. LOngacre 5-0172
Boyce Nemec, *Executive Secretary*

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OF THE

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